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Box (H. E.). **Informe preliminar sobre los taladradores de la caña de azúcar (*Diatraea* spp.) en Venezuela.** [A preliminary Account of the Sugar-cane Borers (*Diatraea* spp.) in Venezuela.]—*Bol. téc. Dep. Ent. Minist. Agric. Venezuela* [6+]117 pp., 19 pls., multigraph. [Caracas] 1947. (With a Summary in English.)

The following is based on the author's summary. Moth borers of the genus *Diatraea* cause serious damage to sugar-cane in Venezuela, involving losses of at least 15 per cent. of the value of the sugar products. A survey in 1946–47 of some of the most important cane-growing regions extending westwards from Miranda State showed that the species of *Diatraea* concerned comprised *D. busckella busckella*, Dyar & Heinr., *D. busckella rosa*, Heinr., *D. canella*, Hmps., *D. impersonatella*, Wlk., *D. saccharalis*, F., and an undescribed species referred to as species B. *D. saccharalis* and *D. lineolata*, Wlk., which has not been recorded on sugar-cane, are also occasionally important pests of maize. *D. brunnescens*, Box, *D. minimifacta*, Dyar, *D. suffusella*, Box, and two other undescribed species (A and C) are known to occur in Venezuela, but are not of economic importance.

An account, based on the literature and the author's observations in other countries, is given of the life-history, habits, ecology, food-plants, economic importance and natural enemies of typical sugar-cane borers of the genus *Diatraea*, with information on factors affecting their abundance and the damage they cause, and comparisons are made with conditions in Venezuela. A classified list of the food-plants (all graminaceous) that are known in Venezuela is given.

The distribution and economic status of the different species, with figures for infestation and intensity (percentage of stalks and joints bored, respectively), are given for each of the principal cane-growing areas of the country. Since these stretch for nearly a thousand miles from east to west, occur from sea level to a height of nearly 6,000 ft. and are separated by mountains and plains, they have distinct types of vegetation that influence the natural distribution of the insects, their food-plants and their natural enemies, and must be considered separately. *D. saccharalis* and *D. canella* are the most widely distributed species, ranging from Sucre State in the east to Táchira in the west. *D. saccharalis* causes most injury after the canes have reached the jointed stage and is estimated to be responsible for about half the total damage by *Diatraea* in Venezuelan sugar-cane, whereas *D. canella* appears to prefer young unjointed shoots, especially in ratoon fields, though it also frequently bores into the tops of jointed stalks. *D. canella* was formerly believed to be confined to the north-eastern part of South America and certain of the West Indian islands, but has recently been found in sugar-cane near San Cristóbal, in Táchira State, near the Colombian frontier of Venezuela. *D. impersonatella*, an important cane borer in Trinidad, has been found attacking sugar-cane in Venezuela only in two localities in Lara State. *D. b. busckella*, previously known only from Panama and Colombia, is the most serious pest of sugar-cane, especially jointed canes, in the western states of Venezuela, from Yaracuy to Táchira, but was not found in the cane-growing regions round Mérida, Ejido, Tovar and La Grita, in the Andean Region, in March 1947. *D. b. rosa* appeared to be endemic in the central region of northern Venezuela, being found only in Miranda, Aragua and Carabobo States and the Federal District. These two forms do not appear to overlap in range, and are by far the most destructive borers in sugar-cane in the regions in which they occur; where either occurs together with *D. saccharalis* field losses may reach 60 per cent. or more. The undescribed species B was reared from sugar-cane at San Cristóbal, Táchira State.

The principal natural enemies of *Diatraea* spp. are discussed in detail, and a list is given of the parasites known from Venezuela, showing their hosts and

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distribution. There are indications that in some regions, notably Sucre and Mérida States, *D. saccharalis* is effectively controlled by the Tachinid, *Paratheresia claripalpis*, Wulp, the most widely distributed Dipterous parasite, which also attacks several other species of *Diatraea*. Another Tachinid, *Stomatodexia* (*Leskiopalpus*) *diadema*, Wied., has been reared from *D. b. busckella* and *D. saccharalis* in widely separated localities. The Braconid parasites of the larvae of *Diatraea* spp. are various species of *Apanteles*, *Ipobracon*, *Agathis* (*Microdus*) and an unidentified genus, among which *I. grenadensis*, Ashm., which parasitises *D. canella*, *D. saccharalis*, *D. lineolata* and possibly *D. b. busckella*, and *A.* (*M.*) *stigmatera*, Cress., which parasitises *D. b. busckella* and *D. saccharalis*, are the most frequent and widely distributed. An Ichneumonid, probably *Spilocryptus diatraeae*, Myers, previously recorded from British Guiana, has been reared from one of the undescribed species of *Diatraea* (C) in *Pennisetum peruvianum* in the Andean region, and the Chalcid, *Spilochalcis dux*, Wlk. (*Heptasmicra curvilineata*, Cam.), a pupal parasite that had previously been recorded from *D. saccharalis* in *Panicum grande*, was found attacking the undescribed species A in the same plant. The fungus, *Cordyceps barberi*, attacks *D. b. busckella* and *D. saccharalis*, and an unidentified fungus occurs on *D. canella* and species C.

The different methods of control used against *D. saccharalis* are discussed, and a brief account is given of the various attempts at biological control made in other countries, the technique used and the results obtained. Under Venezuelan conditions, control by insecticides is considered impracticable, because of the continuity of the generations throughout the year. Practices recommended are the use of uninfested cane for planting, the destruction of all infested stalks left in the fields at harvest and cutting the canes as low as possible. The importance of adequate drainage in the fields to increase the resistance of the plants to insect attack is pointed out, since under existing conditions the root-system is seldom able to develop properly.

Investigations should be directed toward an organised campaign of biological control, but the most pressing need is for further study of the geographical distribution and ecology of the various species of *Diatraea* and of their indigenous natural enemies in Venezuela. When this information is available, the introduction of *Metagonistylum minense*, Tns., and later possibly of *Lixophaga diatraeae*, Tns., should be undertaken. Owing to the great diversity of conditions in the cane-growing regions of Venezuela, there are favourable prospects for the establishment of one or the other of these parasites against *D. saccharalis*. The western regions of Venezuela and Colombia should be explored for parasites of *D. canella*, since a specific parasite of this borer is urgently needed. Central America is suggested as offering the best promise for parasites of *D. b. busckella*, should those of *D. saccharalis* fail to control that species.

STUBBS (L. L.). **A new Virus Disease of Carrots : its Transmission, Host Range, and Control.**—*Aust. J. sci. Res.* (B) **1** no. 3 pp. 303–332, 4 pls., 1 fig., 25 refs. Melbourne, 1948.

This is a detailed account of work begun in 1941, the main features of which have already been noticed from a preliminary report [*R.A.E.*, A **33** 292] on a virus disease that has caused heavy losses of spring-sown carrots in Victoria, especially near Melbourne. Its symptoms are described, and it is stated also to occur in New South Wales [*cf.* **33** 369], South Australia, Western Australia and Tasmania. In experiments, the virus was transmitted to carrot by the Aphid referred to as *Cavariella aegopodii*, Scop. [**33** 292], but not by *Anuraphis tulipae*, Boy., *Hyadaphis foeniculi*, Pass., *Myzus persicae*, Sulz., or *Macrosiphum* spp., all of which commonly infest carrot, or by the Jassids, *Orosius* (*Thamnotettix*) *argentatus*, Evans, *Erythroneura ix*, Myers, and

Empoasca sp. It was also transmitted by core-grafting, but not by mechanical methods, and there was no evidence of transmission through the seed.

Observations indicated that the cultivated carrot appears to be the only economically important host plant of the virus, and a wild strain of *Daucus carota*, which is common in southern Victoria, is the only naturally infected weed. Experimentally, the virus was transmitted by *C. aegopodii* to slender celery (*Apium ammi*), sea celery (*A. australe*), hemlock (*Conium maculatum*), dill, and coriander, but not to celery (*A. graveolens*), caraway, fennel or parsley. A number of cultivated varieties and wild strains of carrot became naturally infected under field conditions, but four local Australian varieties showed marked tolerance.

In Victoria, *C. aegopodii* occurs naturally on carrot, caraway, celery, sea celery, slender celery, fennel, parsley, parsnip, willow (chiefly *Salix vitellina*) and hemlock. The latter, however, does not appear to be a normal food-plant, as all attempts to establish colonies on it failed. Colonies appeared on the leaves of willow of which the winter dormancy was broken under hothouse conditions, indicating that the Aphid overwinters in the egg stage on this tree. A histological study of its feeding in carrot leaves showed that it fed in the phloem and that the passage of the stylets was usually inter-cellular through the cortex. The virus persisted in it for long periods, the duration of which varied directly with that of the preliminary feed on the source of infection, and higher percentages of plants became infected as the periods of feeding on infected and healthy plants were lengthened. Aphids allowed to feed on infected carrot plants for 48 hours remained infective during 18 days in serial transfers. There was no evidence of a latent period.

In two controlled experiments, virus-infected roots were subject to high mortality when transplanted for seed, whereas all healthy roots produced vigorous seed plants. The surviving infected plants were stunted and seed production was greatly reduced. The invert sugar content of virus-infected roots was lower than that of healthy roots.

Carrots free of virus can be obtained in Victoria by delaying the sowing of susceptible varieties until early summer (late November in some districts and mid-December in others). In experiments in 1945, *C. aegopodii* was almost completely eliminated on spring-sown carrots by a spray containing 0·1 per cent. DDT (prepared from an emulsion concentrate containing 20 per cent. p, p′ DDT) applied eight times at intervals of about a week from 12th October to 15th December. By late February 1946, the percentage of infected plants was significantly reduced, as compared with the control, and in April there was a sixfold increase (highly significant) in the yield of marketable roots. Similar treatments with an emulsion containing 0·1 per cent. benzene hexachloride (prepared from a concentrate containing 1·9 per cent. γ isomer) and a spray of nicotine sulphate (1 : 600) and white oil emulsion (1 : 150) also gave good control of the Aphid and significant reductions in infection, but the resultant increases in marketable yield were not significant.

KOTTE (W.). **Krankheiten und Schädlinge im Obstbau und ihre Bekämpfung.** [Diseases and Pests in Fruit Growing and their Control.]—2nd revd. edn., $9\frac{1}{4} \times 6\frac{1}{4}$ ins., viii+329 pp., 8 col. pls., 232 figs., refs. Berlin, P. Parey, 1948.

Apart from an introduction in which it is pointed out that pests and diseases destroy about 20 per cent. of the fruit of all kinds produced in Germany, so that control can be of considerable value, and tables enabling them to be identified from the symptoms they cause, this book consists of three main sections. In the first of these, the various types of harmful biotic and abiotic agents concerned and their chief characteristics are briefly reviewed. Individual

species of insects, fungi, etc., are described in the second, which makes up most of the book, with information on their life-history, the plants they attack, the nature and extent of the damage they cause and methods of control. The third consists of accounts of the composition and uses of numerous insecticidal and fungicidal sprays and dusts and of apparatus for applying them, together with a note on cultural and biological methods of control.

[Shapiro (L. D.).] **Шапиро (Л. Д.). Ptinids and Dermestids destructive to Wood.** [*In Russian.*]—*Ent. Obozr.* **30** no. 1–2 pp. 53–59, 5 figs., 5 refs. Moscow, 1948.

Numerous examples are given from the Soviet Union of injury to articles made of wood by Ptinid and Dermestid larvae in search of pupation sites. The Ptinid chiefly responsible was *Ptinus fur*, L., the habits of which are described. It is common in warehouses in different parts of the Union, and cocoons were found in wooden containers used for various products, such as oilcake, cereals, casein or albumen, usually just above the upper margin of the contents. They occurred in shallow pits in the wood. Damage by Ptinid larvae was also common on wooden cabinets in a museum and on parts of various household articles in contact with the medium in which the larvae developed. A room in a plywood factory in which casein and albumen used as adhesives were stored was found to be infested with both *P. fur* and *P. tectus*, Boield., and signs of injury were observed on boards.

Damage by Dermestids occurred on various wooden structures, including walls, shelves, bins and other containers in leather, fur and plywood factories and was in some cases so severe that replacement was necessary. The species concerned were *Dermestes lardarius*, L., *D. maculatus*, Deg. (*vulpinus*, F.) and *Attagenus piceus*, Ol. The habits of the larvae in seeking sites for pupation are described.

[Osmolovskiĭ (G. E.).] **Осмоловский (Г. Е.). The economic Importance of Weevils causing Exudation of Resin.** [*In Russian.*]—*Ent. Obozr.* **30** no. 1–2 pp. 60–67, 2 figs., 6 refs. Moscow, 1948.

The author gives a list of the species of *Pissodes* that occur in the Soviet Union showing the trees they attack and their distribution there, together with an account of observations on the bionomics and importance of *P. harcyniae*, Hbst., on spruce and *P. piniphilus*, Hbst., and *P. pini*, L., on pine in the Province of Leningrad. The first two proved to be very injurious, but the last was of little importance. These weevils attack trees that are only very slightly weakened or even quite healthy. Feeding and oviposition occur chiefly in the upper or central part of the trunk and in the lower branches. The adults gnaw the cambium for supplementary and regeneration feeding and usually oviposit on the same tree on which they feed, and the larvae tunnel under the bark, all these activities causing abundant flow of resin, which still further weakens the tree. The resin is sufficient to drown the larvae at first, but as a result of progressive weakening, the condition of the tree becomes such as to permit the completion of development. Infested trees are liable to attack by bark-beetles and other pests and eventually die. These subsequent infestations frequently disguise the initial attack by *Pissodes*. The progress of infestation by the two injurious species of *Pissodes* is illustrated by detailed analyses of the condition of two apparently healthy but infested spruces and of a young pine. It is concluded that these weevils are primary pests in that they attack healthy trees, but secondary in that the larvae can complete their development only in those that have been sufficiently weakened.

[Tal'man (P. N.).] **Тальман (П. Н.). On the Horntails** *Sirex gigas* **L. and** *Xanthosirex tardigradus* **Ced. (Hymenoptera, Siricidae).** [*In Russian.*]—*Ent. Obozr.* **30** no. 1–2 pp. 82–87, 1 ref. Moscow, 1948.

The commonest of six species of Siricids observed attacking various trees in the Province of Chita, Transbaikalia, in 1937–38 were *Urocerus fantoma*, F. (*Xanthosirex tardigradus*, Cedj.) on larch (*Larix dahurica*) and *U.* (*Sirex*) *gigas*, L., on *L. dahurica* and pine (*Pinus sylvestris*). The male of the former is described for the first time. The adults were on the wing from 22nd June to 1st August, and eggs were laid in weakened but living trees as well as in freshly felled ones, though the latter were preferred. They were inserted into the wood in places from which the bark had been removed, or where it was split or otherwise damaged. In the laboratory, the larvae tunnelled in the wood to a depth of over 2 ins., the pupal stage lasted 9 days in one case and 12 in another, and the adult males and females survived for 3–7 and 8–13 days, respectively. Eggs laid in blocks of wood in July 1938 did not give rise to adults until May 1940.

The adults of *U. gigas* were on the wing from 22nd June to 3rd September and oviposited in both weakened and vigorous trees. In blocks in the laboratory, the life-cycle was completed in two years. Males and females survived for an average of 5 days.

Mitchell (B. L.). **White Grub Control in Tobacco Lands.**—*Rhod. agric. J.* **43** no. 6 pp. 499–504 ; also as *Bull. Minist. Agric.* [*S. Rhod.*] no. 1373, 7 pp. Salisbury, S. Rhod., 1946.

The author summarises the information available on Lamellicorn larvae as pests of tobacco in Southern Rhodesia and outlines a long-term plan for the prevention and control of infestation. Cultivated soils are infested by species of *Anomala*, *Schizonycha* and *Adoretus* [*cf. R.A.E.*, A **37** 69], and most of these are widely distributed in the Colony, the same general complex of species prevailing throughout the important tobacco-producing areas. Their life-cycles are essentially similar ; there is one generation in the year, and oviposition occurs in the soil in spells of wet and cloudy weather between late September and early December. The larvae hatch in about three weeks and feed primarily on rotting vegetation in the soil, probably damaging tobacco plants only when these are in their direct line of advance. Full-grown grubs are most numerous and injurious to tobacco between Christmas and the third week in January. They pupate from the end of January, and adult emergence takes place during the rains, ceases during the cold weather and is completed during August and September.

The adults fly at night and feed on the young tender foliage and flowers of many indigenous trees, being particularly attracted to the foliage of growth regenerated from damaged tree roots. Destroying the foliage by a good scorching grass fire in mid-October deprives the beetles of food, so that they either move elsewhere to feed and oviposit or remain and lay reduced numbers of eggs. It is thought that adequate protection would be given to a tobacco field if a belt 500 yards wide were burnt round the field and all regenerate growth within the field removed. Windbreaks would have to be burnt at the same time if of indigenous trees, and therefore should be composed of exotic species.

There is a very close correlation between grub population and loss of stand, and any reduction in the total population is immediately reflected in a better stand of plants. If compost is applied before oviposition occurs, it will attract certain species and cause very heavy oviposition and consequent grub population, but if the application is delayed until after oviposition is completed there will be no increase in population [*cf. loc. cit.*]. A ploughed field is almost certainly more attractive to ovipositing females than an unploughed one, and ploughing should therefore be delayed until the last week of November.

Ground for other crops may be ploughed at any time during the winter and will attract ovipositing females away from the tobacco fields in spring. Where new ground, grass fallows or green manures are ploughed in at the end of the rains, a heavy concentration of larvae will occur during the following season, because the resulting comparatively high humus content of the soil attracts the ovipositing females. Gammexane [benzene hexachloride] gives a very good kill of larvae [*cf.* **36** 137], though the most economically efficient dosage and its method of application have not been ascertained, and this should be applied early to the newly ploughed land to anticipate infestation. Tobacco transplants are susceptible to attack during the first 4–5 weeks after planting out ; after this they are not damaged whatever the population in the soil. If tobacco is transplanted in the third or fourth weeks of December, the susceptible period coincides with the period of maximum larval activity, but if transplanting is done not later than 15th November damage will be reduced to a minimum, and tobacco planted before 10th December will be seriously damaged only by a heavy infestation. It is suggested that if benzene hexachloride is not available, heavily infested ground should be planted first and lightly infested ground later, but if benzene hexachloride is available, it should be used on the heavily infested ground, and lightly infested ground should be planted before 17th December and before the treated ground. It is useless to apply benzene hexachloride later than 15th November, as it is very slow in action.

Where virgin country is being cultivated, it is probable that Lamellicorn larvae will not be numerous for the first few years. However, they are indigenous in the sand veldt and increase to enormous populations in a few years under the favourable conditions provided by large areas of cultivated land unless suitable precautions are taken.

CHORLEY (J. K.). **Report of the Division of Entomology for the Year ending 31st December, 1945.**—*Rhod. agric. J.* **43** no. 6 pp. 547–562 ; also as *Bull. Minist. Agric.* [*S. Rhod.*] no. 1377, 17 pp. Salisbury, S. Rhod., 1946.

In the agricultural section of this report it is recorded that no invasion of Southern Rhodesia by *Nomadacris septemfasciata*, Serv., occurred in 1945. Some maize planted in the Salisbury district in time to take advantage of the early thunderstorm rain was severely damaged by *Busseola fusca*, Fuller, in January, and another crop planted on 12th December was practically destroyed in the fourth week of the month by cutworms thought to belong to the genus *Euxoa* ; evidence suggested that the land had not been kept clean before it was prepared for planting, and that 5,000–10,000 caterpillars were present per acre in the more heavily infested places. Investigations on the life-cycle and control of *Exora discoidalis*, Jac., and *E. apicipennis*, Jac. [*cf. R.A.E.*, A **33** 126] confirmed that ploughing fields of sunn-hemp [*Crotalaria juncea*] during the dry season appreciably reduced the population of these Galerucids, and indicated that ploughing early, when the larvae are still active, was more effective than ploughing late in the dry season. The estimated populations were lower than in the previous year, and the main emergence at Salisbury occurred after heavy rains in December.

Considerable infestation of potato foliage by *Gnorimoschema operculella*, Zell., was reported in January and October, and infested tubers were lifted on one isolated farm in December. Cutworms destroyed tobacco seed-beds in widely separated areas in November, and Lamellicorn larvae were injurious in tobacco fields [*cf.* preceding abstract]. As many as 300 holes of the Gryllid, *Brachytrypes membranaceus*, Dru., were present per acre in some fields ; in early spring the crickets were found to be feeding on dead tobacco leaf, dry grass and fallen

leaves of *Isoberlinia*. *Hellula undalis*, F., caused severe damage to cabbage and cauliflower by boring in the stems in June, but *Bagrada hilaris*, Burm., was scarce on crucifers, possibly owing to severe winter frosts, and caused no damage until September. Adults of *Ceratitis* (*Pterandrus*) *rosa*, Karsch, and *C. capitata*, Wied., were reared in October from peaches gathered in Salisbury in late September. On *Citrus*, *Coccus hesperidum*, L., was scarce and development of *Aonidiella aurantii*, Mask., was effectively checked by the fungus, *Fusarium cocciphilum*. There were very localised outbreaks of *Scirtothrips aurantii*, Faure, attacks by *Aphis citricidus*, Kirk. (*tavaresi*, Del G.), were generally negligible, and *Ceratitis capitata* was injurious only in late September and early October. There were several new records in Salisbury of *Orthezia insignis*, Browne, which injures ornamental trees in Umtali [*cf.* **34** 33]. Heavy outbreaks of *Ceroplastes* sp. damaged *Dodonaea* hedges in Bulawayo in March, and *Aspidoproctus maximus*, Newst., occurred in outbreak proportions on the tree, *Brachystegia randii*, near Salisbury. In September, parts of *Pyracantha* hedges were destroyed by *Pseudococcus* sp. and defoliated by larvae of the Lasiocampid, *Pachypasa sericeofasciata*, Auriv., the latter being readily controlled by spraying with lead arsenate. *Cylas formicarius*, F., was thought to be still present in Salisbury on the premises on which it was first discovered [*cf.* **33** 126]; all the sweet potatoes were dug up in January and re-growth periodically removed. The information on pests of cotton has already been noticed from an earlier account [**35** 339].

Pests of stored products included *Ephestia cautella*, Wlk., attacking dehydrated onions that had increased in moisture content from 2 to 13 per cent. in storage, a species of *Anthrenus*, possibly *A. fasciatus*, Hbst., attacking brushware, on which it was probably imported from India, and woollen cloth, and *Tribolium confusum*, Duv., found breeding in tobacco seed in August. Unusually large numbers of *T. castaneum*, Hbst., from the large maize storage sheds at Glendale infested houses in the neighbourhood late in December. An inspection of the railway sheds in Beira, Mozambique, in which tobacco from central Africa awaits shipment overseas, resulted in the discovery of three dead adults of *Lasioderma serricorne*, F., on the woodwork supporting the walls of one shed, but of no other insects of importance.

Small-scale tests confirmed that the reactions of insects to deposits of DDT vary according to the nature of the treated surfaces. Species of *Exora* required contact for a much longer period than house-flies (chiefly *Musca domestica vicina*, Macq.), and grasshoppers and cockroaches were not affected under the conditions of the experiments.

THERON (P. P. A.). **Studies on the Provision of Hosts for the Mass-rearing of Codling Moth Parasites.**—*Sci. Bull. Dep. Agric. S. Afr.* no. 262, 38 pp., 7 pls., 65 refs. Pretoria, 1947.

Work on the biological control of the codling moth, *Cydia* (*Carpocapsa*) [*pomonella*, L.], in orchards in South Africa [*cf. R.A.E.*, A **31** 219] has been hindered by the lack of a suitable method of obtaining hosts for the mass breeding of its larval and pupal parasites. The collection of larvae from trap bands on the trees provides only a seasonal and fluctuating supply, requires a considerable amount of labour, and involves a risk of introducing *Pediculoides* sp. or fungous or bacterial infections into the laboratory. Larvae can also be obtained from infested fruits removed during thinning operations, but this also yields only a temporary supply. Rearing the larvae on their natural foods in the laboratory is impracticable on a large scale owing to the cost, the space required and the inconstancy of supply, and the obligatory diapause of the

larvae is an obstacle to obtaining pupae at will for the rearing of pupal parasites.

In view of these difficulties, special investigations on the provision of laboratory hosts were begun in 1942. Of the various moths tested as alternative hosts, *Argyroploce leucotreta*, Meyr. [*cf.* **37** 55] proved the best and showed promise as a host for *Cryptus* sp., *C. sexannulatus*, Grav., and *Pimpla heliophila*, Cam. To obtain the necessary larvae and pupae, both *Cydia* and *Argyroploce* were reared on artificial foods by the method of Ripley *et al.* [**28** 641], which is described in detail. Eggs were laid on pieces of paper removed daily from the oviposition cages, and since the eggs have to be sterilised, a well-polished writing paper that retained the desired small amount of disinfectant solution, but did not allow it to penetrate to the susceptible under surface of the eggs, was used. The eggs were sterilised by immersion for 60–90 seconds, the best results being obtained with 8 per cent. formaldehyde or 0·1 per cent. mercuric chloride, and washed. The rearing medium consisted of 100 ml. maize meal wetted with 60 ml. water in glass jars measuring 5×3 ins. These were plugged with cotton-wool and sterilised at 20 lb. steam pressure per square inch for 30 minutes. The medium was inoculated with a suspension of spores of *Mucor hiemalis* or other suitable fungi and the egg-papers introduced in a special aseptic chamber, and the jars were then kept at 80°F. and 80 per cent. relative humidity. When the larvae become full-fed, over 60 per cent. of them crawl to the plugs for pupation and such plugs can be exposed directly to parasites or larvae from them removed from their cocoons and transferred to rolls of corrugated paper. Considerable numbers of mature larvae can also be secured by placing small rolls of corrugated cardboard on the rearing medium at the time of maximum maturation of the larvae.

For the maintenance of stocks, some pupae were allowed to transform to adults. Moths of both sexes of *Argyroploce* in random proportions were placed in wire-gauze oviposition cages and 5 per cent. sucrose solution on cotton-wool supplied as food. Mating took place readily, and eggs were laid on the papers about 48 hours after emergence. Males and females of *Cydia* were kept apart for 1–2 days at 80°F. and 80 per cent. relative humidity and then introduced into large glass jars in the ratio of 15 males to 12 females. They paired overnight, and eggs were laid one or two nights later. Fertilised females also oviposited readily in the wire cages used for *Argyroploce*. The cages were kept at 80°F. and 70–80 per cent. humidity.

The literature on the nutritive requirements of phytophagous chewing insects and the importance of micro-organisms in nutrition is reviewed, and experiments are recorded which showed that the intestines of the larvae of *C. pomonella* contain amylase, invertase and lipase. In tests with different breeding media, maize meal promoted the growth of *Argyroploce* and *Cydia* more than oatmeal, and the number of adults produced was increased for *Argyroploce* but not to any extent for *Cydia* by the addition of soy-bean meal, groundnut meal or linseed oil-cake meal, usually in the proportion of 1 : 3. Three unidentified species of fungi were found to possess the same growth-promoting qualities as *M. hiemalis*, and two of them, thought to belong to the genus *Rhizopus*, were used exclusively for the mass breeding of *Argyroploce*. They established themselves on both oatmeal and maize meal much better than *M. hiemalis*, produced greater mycelium growth, and were more resistant to suppression by yeasts, bacteria, *Aspergillus* or *Penicillium*.

The production of *Argyroploce* proved reasonably high and not expensive, but that of *Cydia* was at all times low and the larvae obtained usually entered diapause. Attempts to break this by repeated compulsory spinning [**32** 89] resulted in complete mortality, and almost all larvae stored at room temperature or at 40°F. for over two months also died. Few adults were obtained from

laboratory-reared larvae that hibernated, and many of these, though of normal size, were abnormal in other ways. It is concluded that the rearing of *Cydia* on artificial media has not yet reached the stage at which mass production is possible.

McDougall (W. A.). **Investigations in the Control of Wireworms (*Lacon variabilis* Cand.) in Canefields with " Gammexane ".**—*Qd J. agric. Sci.* **4** no. 4 pp. 140–150, 13 refs. Brisbane, 1947.

Wireworms (chiefly *Lacon variabilis*, Cand., with at most a one-year life-cycle) injure sugar-cane setts in Queensland almost every year, especially in the wetter districts. As a result, the gaps in the rows have to be replanted and farming routine and practices are upset. The damage can be reduced by the provision of improved soil drainage during the wet season previous to planting [*cf. R.A.E.*, A **24** 438] and by late planting, though the latter involves risks of its own, but these practices have been adopted for the most part only incidentally, in spite of the fairly accurate general forecasts of wireworm abundance issued in central Queensland. This neglect has probably been due to the impossibility of forecasting the population in any particular field and to the absence of any constant correlation between population level and damage. Chemical control has so far proved impracticable, but with the discovery in England that benzene hexachloride persisted in the soil and immobilised wireworms [*cf.* **36** 281], further tests were carried on in 1946. The material was used in the form of Gammexane (a proprietary dust containing 10 per cent. benzene hexachloride and 1·3 per cent. γ isomer). In preliminary pot experiments, in which Gammexane was mixed with soil at concentrations ranging from 1 : 250 to 1 : 50,000 and the cane-sett roots served as indicators, it showed itself to be very persistent in the soil despite watering, the loss in strength being practically negligible over a period of eight months. It injured the roots, the primary roots more than the secondary ones, and damaged roots did not recover. Older wireworms were quickly immobilised by Gammexane at a concentration of 1 : 1,500, but some were still alive six weeks later.

In field experiments Gammexane was first applied by hand at rates of 12½–100 lb. per acre in soil placed directly over the setts in the drills at planting time or in fertiliser after the setts had received a preliminary cover of ½-in. soil. The setts were planted in mid-July and examined in early September, when secondary rooting was beginning. It was found that all the direct treatments prevented wireworm damage but markedly reduced rooting, as compared with the controls. The indirect treatments greatly reduced damage, 100, 50 and 25 lb. per acre to a significantly greater extent than 12½ lb., and all improved rooting, though the highest rate did so significantly less than the two lowest. The best rate from both points of view appeared to be 25 lb. per acre. In further tests, in which all applications were direct, Gammexane at 30–400 lb. per acre gave complete or almost complete protection from wireworm damage but injured the roots at all but the lowest rate, while at 20–40 lb. per acre, it gave a high degree of protection and increased rooting at all rates, especially at the highest when mixed with fertiliser.

In mid-September, a trial was set out on the land used in the first series of tests. Gammexane was applied in fertiliser at about 12 lb. per acre to half-plots by means of a specially adapted apparatus giving the equivalent of an indirect application. The method proved satisfactory and though wireworms were present and active from July to September and usually persisted in the field until October, the stand of cane obtained was the best for many years and was slightly better on treated ground than on that receiving fertiliser only.

KELSEY (J. M.). **A preliminary Report on Timber Preservation with Wolman Tanalith in New Zealand.**—*N.Z. J. Sci. Tech.* **28** (B) no. 3 pp. 136–144, 2 figs., 4 refs. Wellington, N.Z., 1947. **A preliminary Report on Timber Preservation with Celcure for New Zealand grown** *Pinus radiata.*—*T.c.* pp. 145–153, 2 figs., 6 refs.

The results are given in these two papers of experiments in 1945–46 in New Zealand similar to those already noticed [*R.A.E.*, A **36** 414] on the value in preventing infestation of timber of *Pinus radiata* by *Anobium punctatum*, Deg., of pressure treatments with Tanalith, a Wolman salt containing sodium fluoride, sodium chromate, sodium arsenate and dinitrophenol, and Celcure, which varies slightly in composition but consists essentially of potassium dichromate, copper sulphate and acetic acid or chromium acetate, and sometimes a small amount of boric acid. A 2 per cent. aqueous solution of Tanalith was applied under pressure to dressed studs of *P. radiata*, measuring 8 ft. × 4 ins. × 2 ins., in February 1945, about ten months after the trees had been felled, to give an average dry-salt retention for the complete run of 0·25 lb. per cu. ft. timber. Samples were taken from the sap- and heartwood at the ends and centres and, after being stored under cover in sunshine for three weeks, cut into test blocks, which were left for a further 37 days before use. For the tests with Celcure, four samples of *P. radiata*, measuring $27\frac{1}{2}$ ins. × $1\frac{3}{4}$ ins. × $1\frac{3}{4}$ ins., that had been treated in Glasgow in 1940 with 4 and $7\frac{1}{2}$° Twd. solutions were used ; the absorption in one of heartwood was 1·2 gals. per cu. ft. and that in the other three, which were of sapwood, varied from 3·82 to 5·1 gals. per cu. ft. Penetration by both preparations was complete except round knots and, in the case of Tanalith, in the central pith.

Oviposition compulsion and preference tests [*cf. loc. cit.*] begun in November 1945 showed that neither preparation exerted any appreciable repellent effect or, in general, prevented the larvae from entering the wood, but larvae that did enter did not as a rule penetrate so far as others in untreated wood. Mortality after the first two months in wood treated with Tanalith was very high, and no living larvae were recovered in May 1946, but natural mortality in timber of *P. radiata* that has been felled for less than two years is also high. Celcure hindered the entry of the larvae to some extent, and mortality after the first month among larvae that did enter was very high ; again, no living larvae were recovered in May. Larval susceptibility tests [*loc. cit.*] were begun in April 1945, and examination in the following August showed that, for both preparations, the dust in the galleries consisted almost entirely of wood that had been gnawed off and discarded, whereas that in untreated blocks was characteristic frass. Frass was more abundant in the zones in which penetration was less complete. The surviving larvae were transferred to other treated or untreated wood, and a further examination was made in January, when all the larvae in wood treated with Tranalith were dead ; it is pointed out, however, that unseasoned wood, such as was used in the tests, is unsuitable for *Anobium*. Less than half the larvae in blocks treated with Celcure were dead, but the survivors were small and unhealthy, and five that were again transferred to other treated blocks were all dead by March.

The tests indicated that the establishment of the larvae could be prevented by treating the wood with either material to a depth of $\frac{1}{2}$ in. or so, but in view of the deep cracks that often develop in timber, and the untreated surfaces exposed by cutting, using nails that are subsequently withdrawn, etc., and later by the emergence of adults that develop from any larvae that do become established at these sites, complete penetration of timber up to 2 ins. in thickness is recommended. Notes on the use of the two materials in other countries are given in appendices.

HARROW (K. M.). **A Note on the Occurrence of *Coptotermes* Nymphs in Hardwoods from Australia.**—*N.Z. J. Sci. Tech.* **29** (B) no. 4 p. 223, 1 fig., 2 refs. Wellington, N.Z., 1948.

Although it was suspected that established colonies of *Coptotermes acinaciformis*, Frogg., in New Zealand originated from nymphs introduced in hardwoods from Australia [*cf. R.A.E.*, A **33** 234], only workers and soldiers, which cannot reproduce, had been found in such consignments. In April 1947, however, a post containing nymphs with well-developed wing-buds was found in a shipment of hardwood from Australia. Such nymphs can mature normally and give rise to alates that reproduce, or may become supplementary reproductives without maturing normally [*cf.* **34** 169]. The danger involved in their introduction is thus obvious.

WISHART (G.). **Further Observations on the Changes taking Place in the Corn Borer Population in western Ontario.**—*Canad. Ent.* **79** no. 5 pp. 81–83, 1 graph, 7 refs. Guelph, Ont., 1947.

There is an increasing tendency for *Pyrausta nubilalis*, Hb., to produce a second generation in the year on maize in western Ontario [*cf. R.A.E.*, A **31** 457; **33** 138], as in Ohio [*cf.* **37** 154], and since overwintered larvae of a multivoltine strain have been shown to pupate earlier than those of a univoltine one, this characteristic was used to investigate the population at Colchester, in Essex County, the area in Ontario where the tendency has increased most rapidly. Larvae from this area, from Ridge Road, Prince Edward County, where there is little evidence of more than one generation a year, and from New England, where there has always been more than one, were kept over winter, so that their diapause requirements were completely satisfied, and incubated at 75°F. Pupation occurred after mean periods of 27·8, 34·3 and 21·3 days in the three groups, respectively; the differences being highly significant, and it was concluded that the population in Essex County is in a state of transition. The ultimate proportion of the population to develop the two-generation habit will depend on meteorological conditions. The trend has been observed as far east as Lennox and Addington County and probably occurs to some extent throughout Ontario, though it diminishes rapidly to the north and east as the seasons grow shorter and cooler.

Confirmation of the existence of different biological strains of *P. nubilalis* [**33** 151] is provided by the fact that whereas in New England the larvae have been reported as habitually attacking over 200 plants other than maize [**17** 363], in Ontario and Ohio attack on other plants is quite limited, and although it was reported from western Ontario in 1943 [**33** 139], weather conditions were abnormal at the time and it did not recur in the following year. The multivoltine strain in the Ontario population is thus distinct from the true multivoltine strain of New England.

HAWBOLDT (L. S.). *Bessa selecta* (**Meigen**) (**Diptera : Tachinidae**) **as a Parasite of** *Gilpinia hercyniae* (**Hartig**) (**Hymenoptera : Diprionidae**).—*Canad. Ent.* **79** no. 5 pp. 84–104, 30 figs., 37 refs. Guelph, Ont., 1947.

Ptychomyia (*Bessa*) *selecta*, Mg., the synonymy of which is discussed, is known in Canada as a parasite of the larch sawfly, *Pristiphora erichsoni*, Htg. [*cf. R.A.E.*, A **32** 176; **34** 173], but its eggs and integumental funnels have also frequently been found on larvae of the European spruce sawfly, *Gilpinia*

hercyniae, Htg. The bionomics of the Tachinid were, therefore, studied with a view to determining its value as a possible factor in the control of *G. hercyniae*. Its various hosts and world distribution are reviewed from the literature, and its immature stages are described. There are two generations a year in Nova Scotia and New Brunswick and the first-instar larvae from eggs laid by adults of the first generation overwinter within the hibernating larvae of the sawfly. They occurred in larvae of *G. hercyniae* from about the end of August until early May, when the first individuals of the second instar were found. Pupation began between 5th and 14th June, and the adults emerged from 5th to 18th July. They paired as soon as they were put in a warm sunny place, and the females oviposited three days later. Larvae of the first generation were first observed on 16th July, but probably hatched a few days earlier, and puparia were formed from 19th July to 26th August. The adults emerged between 31st July and 16th September, the females oviposited about six days after pairing, and the eggs gave rise to larvae that overwintered.

The eggs are laid on any part of the host larvae, fifth-instar individuals being preferred, and though only one parasite will apparently reach maturity in an individual host, as many as 29 eggs have been found on one larva. In the insectary, adults fed on sugar and water lived for a maximum of 35 days, with an average of 15, and the oviposition period in the overwintered generation lasted about two weeks. The total number of eggs laid by a female was thought to be about 100, and the percentage of females among the adults reared was 46·4. The egg stage apparently lasts about 24 hours, and on hatching, the larva enters the host through a slit in the integument. The processes of hatching and larval development are described. The development of the host is not interrupted until the parasite has reached the third (last) instar. Pupation takes place in the soil, sometimes inside the cocoon of the host. Most often, the parasite larva leaves the fifth-instar host larva and drops to the ground. Parasites of the first generation frequently do not make their way out for pupation until the host is in the eonymphal or pronymphal stage, because the host larvae mature before the parasite larvae have become full-fed.

The value of *P. selecta* as a parasite of *G. hercyniae* is reduced by such factors as the sloughing of its eggs by hosts that are ready to moult ; rather high mortality of larvae inside the eggs ; the dislodging of the newly hatched larvae before they enter the host ; occasional sloughing of established first-instar larvae with the host exuviae ; superparasitism ; imprisonment and death of the overwintering larvae in a hard sclerotised sheath within the host ; and mortality of the young adults unable to emerge from cocoons of the host because of inadequate apertures made by the larvae before pupation. Records of parasitism of *G. hercyniae* for larvae collected in the field in New Brunswick showed that total parasitism amounted to 5·4 per cent. ; most of this was accounted for by what the author terms successful parasitism (in which the host dies and the adult parasite emerges) and partially successful parasitism (in which both host and parasite die), and the rest by unsuccessful parasitism (in which the host survives but the parasite dies). In more detailed studies, the total percentage parasitism of larvae varied from 0·9 to 25, with completely and partially successful parasitism ranging from 0·6 to 10·7 per cent. The fairly high percentages of parasitism occasionally observed occurred only in spruce stands that were mixed with larch or were adjacent to larch stands in which *Pristiphora erichsoni* was more than usually abundant. The Tachinid appears, therefore, to be primarily a parasite of *P. erichsoni*, at least in Nova Scotia and New Brunswick.

Other sawflies from which the author reared *Ptychomyia selecta* were *Pristiphora geniculata*, Htg., *Pikonema alaskensis*, Rohw., *P. dimmocki*, Cress., and *Neodiprion abietis*, Harr. It was rarely taken from Lepidopterous larvae, including *Nymphalis antiopa*, L., and *Nepytia canosaria*, Wlk.

Gunther (F. A.) & Tow (L. R.). **Inhibition of the catalyzed thermal Decomposition of DDT.**—*Science* **104** no. 2696 pp. 203–204, 1 fig., 11 refs. Lancaster, Pa., 1946.

Since most technical DDT contains traces of iron or iron salts by the time it reaches the surface being treated, and these materials are known to catalyse the dehydrohalogenation of the compound [*cf. R.A.E.*, A **34** 157; **35** 412, 413], a preliminary report is given of two substances that were found to inhibit the iron-catalysed thermal decomposition of DDT. When 1·5 per cent. ferric nitrate, 2 per cent. picolinic acid or salicylal-amino-guanidine and 96·5 per cent. iron-free technical DDT were mixed intimately and kept at a temperature of 110–120°C. [230–248°F.] for 24 hours, the percentage dehydrohalogenation [*cf.* **37** 296] was negligible (1 and 2·5, respectively), whereas without the inhibitors it was 114 under the same conditions. Still lower concentrations of picolinic acid or salicylal-amino-guanidine might be equally effective, but have not been tested. It is evident that the inhibition of the iron-catalysed thermal decomposition of DDT is not attributable solely to mere buffer action, since extensive dehydrohalogenation takes place in the presence of calcium dihydrogenphosphate or sodium carbonate.

Ingram (J. W.), Bynum (E. K.) & Charpentier (L. J.). **Tests with new Insecticides for Control of the Sugarcane Borer.**—*J. econ. Ent.* **40** no. 6 pp. 779–781. Menasha, Wis., 1947.

Several new insecticides were tested on field plots of sugar-cane and sorghum in Louisiana in 1943–46 for the control of larvae of *Diatraea saccharalis*, F., since cryolite, which is widely used against them, is expensive and sometimes causes heavy increases in *Sipha flava*, Forbes, or some foliage injury. Tests on sugar-cane were made against the first generation in spring, against the second or third generation in tall cane, and against the third and fourth in summer-planted cane in September. In most cases applications were made four times at weekly intervals from the time the eggs hatched.

Dusts containing 10 per cent. DDT or methoxy-DDT and sprays containing suspensions or emulsified solutions of DDT gave very unsatisfactory control of *D. saccharalis* and usually resulted in increases of *S. flava*; dusts of 10 per cent. sabadilla and 5 per cent. chlordane were also insufficiently effective. In 1945, undiluted *Ryania* dust gave much better control of the second generation than synthetic cryolite, and 25 per cent. *Ryania* dust was apparently somewhat more effective than cryolite against the third and fourth generations. In 1946, dusts containing 50 per cent. *Ryania* applied three times at ten-day intervals and 25 per cent. dusts applied four times at weekly intervals gave about the same control of the first generation as cryolite applied four times, and 50 per cent. *Ryania* gave about the same control of the third and fourth generation on summer-planted cane as cryolite. Undiluted *Ryania* caused no increase in Aphid populations and did not injure the foliage, and 50 per cent. *Ryania* dust gave 48 per cent. control of third-generation borers attacking sorghum and did not injure the foliage. Benzene-hexachloride dusts containing 1 and 1·5 per cent. γ isomer were as effective as cryolite against the first generation on sugar-cane, but a dust containing 1·15 per cent. γ isomer was somewhat less effective against the second generation, and 2 per cent. dusts were more effective than cryolite against borers in summer-planted cane in 1945 though much less so in 1946. The numbers of Aphids were significantly lower in plots treated with 1·15 per cent. γ benzene hexachloride than in those treated with cryolite or 50 per cent. sodium fluosilicate, and plots treated with benzene hexachloride yielded 1,025 lb. more sugar per acre in one experiment and 321 lb.

more in another than untreated plots. A dust containing 2 per cent. γ benzene hexachloride gave 27 per cent. control of the third generation in sorghum. No foliage injury to either sugar-cane or sorghum was observed. A dust containing 10 per cent. chlorinated camphene [toxaphene] gave better control than cryolite of the first generation and of the third and fourth generations on summer-planted cane, but a 5 per cent. dust was somewhat less effective than cryolite against the latter. This material caused no injury to sugar-cane foliage and resulted in significantly fewer Aphids than cryolite or 50 per cent. sodium fluosilicate.

George (J. L.) & Mitchell (R. T.). **The Effects of feeding DDT-treated Insects to Nestling Birds.**—*J. econ. Ent.* **40** no. 6 pp. 782–789, 5 refs. Menasha, Wis., 1947.

In field tests on the effect of feeding the young of wild Passerine birds with insect larvae and pupae that had been sprayed with DDT, carried out in New York State between 3rd June and 6th August 1946, 28 nestlings in eight nests were fed from the third or fourth day of life with 25 per cent. of their weight of contaminated food each day and nine birds in two nests with 50 per cent. of their weight. The parents provided additional food and all the care required. In laboratory tests, 52 birds from 14 nests were taken into the laboratory on the third or fourth day of life, fed with as much contaminated food as they would take on the first two days and on a starvation diet of 25 per cent. of their weight on the third, and then returned to the nests. The food supplied consisted of larvae of the spruce budworm [*Choristoneura fumiferana*, Clem.] and larvae and pupae of the corn borer [*Pyrausta nubilalis*, Hb.] that had been subjected to spraying with 1 lb. DDT per acre. In the field tests, this caused no apparent injury to the birds, but in the laboratory it killed 20 per cent. of them and a further 22·7 per cent. showed signs of DDT poisoning. There was some indication that certain species were less susceptible to DDT poisoning than others.

The field tests simulated the conditions that obtained during work in the Adirondacks on the control of *C. fumiferana* in mixed forests of spruce [*Picea*] and balsam [*Abies balsamea*], when a spray of 1 lb. DDT per acre was not sufficient to exterminate the insects in the treated area. The diet of nestlings would therefore consist of both sprayed and unsprayed insects, and it is concluded that healthy birds would not be likely to succumb to DDT poisoning in areas of this kind. If a large forested area were treated with DDT at a rate sufficient to eradicate the insect population while young birds were being fed in the nests, some of these, being supplied with poisoned insects just after the spraying was done and not receiving sufficient food later owing to a scarcity of insect life, would probably succumb to poisoning or to a combination of weakness and poisoning.

Berry (P. A.). *Anthonomus vestitus* **and its natural Enemies in Peru, and their Importation into the United States.**—*J. econ. Ent.* **40** no. 6 pp. 801–804, 3 refs. Menasha, Wis., 1947.

Anthonomus vestitus, Boh., a major pest of cotton in Peru, is attacked there by three important parasites, *Catolaccus townsendi*, Crwf., *Triaspis vestiticida*, Vier., and *Bracon* (*Microbracon*) *vestiticida*, Vier. The last two of these were sent to the United States and liberated against *A. grandis*, Boh., on cotton in 1941–45, but *C. townsendi* was already known as a parasite of *A. grandis* in the United States, where it has been recorded as *C. hunteri*, Crwf. [*cf. R.A.E.*, A **23** 385, etc.]. Both introduced species attacked *A. grandis* and have been

recovered from this weevil in areas in which liberations were made, but are not known to have become established [*cf.* **37** 105].

In the course of collecting and rearing these parasites, numerous data were accumulated on *A. vestitus* and its natural enemies in Peru. It feeds on the tender terminal shoots and squares of cotton ; the adults fly well and are apparently able to disperse rapidly. The larvae develop entirely within the squares and as many as 5 may be present in each. The larval and pupal stages and complete development last 8–14, 5–12 and 16–30 days, respectively, and there are 4–6 generations a year. Infestation increases rapidly between March and July in northern Peru and reaches its peak in February or March in the south, where ratoon cotton is cultivated. Adults of *B. vestiticida* hover round the cotton squares and are most active from 9.30 a.m. to noon and fairly active from 3 to 6 p.m. on bright days and most active from 11 a.m. to 2 p.m. on cloudy ones. The eggs are deposited singly on the larvae of *A. vestitus* within the squares and hatch in 2–3 days. The larvae feed for 4–5 days, and complete development requires 2–3 weeks during May and June. The percentage parasitism of *A. vestitus* by *B. vestiticida* in the Canete Valley in 1941 was 10·5 on 12th May and 25 on 5th July. The eggs of *T. vestiticida* are deposited in the eggs of *A. vestitus* and possibly also in the young larvae. The parasite larva develops within the host larva for a time, but apparently feeds externally for a short period before spinning its cocoon within the square. Development lasts 2–3 weeks in northern Peru during July and August. Parasitism by *T. vestiticida* is usually low during the first part of the season and does not increase noticeably until the host population becomes rather dense, but from the end of June to the end of September, it increases rapidly and reaches a high figure ; under favourable conditions in one locality, it reached 89·2 per cent. *T. vestiticida* was found in large numbers only in northern Peru. The eggs of *C. townsendi* are deposited externally on the larvae of *A. vestitus* and the larvae feed externally, 1–3 or more developing on the same host. They pupate within the cotton bud, and complete development lasts 2–3 weeks.

Eupelmus cushmani, Crwf., appeared in small numbers in the rearing cages and was probably parasitic on *A. vestitus*, but was so infrequent as to be ineffective. Several samples of infested squares were exposed to females for 5–7 days, but no oviposition was noted and no parasites of this species resulted. Another species of *Eupelmus*, *Eurytoma tylodermatis*, Ashm., and an unknown species of *Eurytoma* also appeared in the rearing cages, but were not proved to attack *A. vestitus*. *Pediculoides ventricosus*, Newp., was observed many times and is said to be effective against *A. vestitus*, sometimes killing 20 per cent. of the larvae, pupae and adults.

ALLEN (T. C.). **Suppression of Insect Damage by Means of Plant Hormones.**—*J. econ. Ent.* **40** no. 6 pp. 814–817, 34 refs. Menasha, Wis., 1947.

The author discusses, largely from the literature, the similarities that have been observed between the changes in plant growth caused by insect feeding and those induced by applications of plant hormones. Similar enzyme activities are apparently involved, and it may prove possible to explain the effects of the toxins sometimes injected by insects during feeding on a basis of growth-regulating factors. It has been found that the application of hormones to bean plants prevents blossom and pod drop due to *Lygus* feeding in the United States and that certain insecticides, particularly DDT, may possess hormone-like qualities and cause increases in plant growth. It would be of considerable importance in insect control if chemicals could be found that would not only kill insects but also inhibit plant damage caused by them and improve the quality of the plant itself.

Woglum (R. S.), LaFollette (J. R.), Landon (W. E.) & Lewis (H. C.). **The Effect of Field-applied Insecticides on beneficial Insects of *Citrus* in California.**—*J. econ. Ent.* **40** no. 6 pp. 818–820. Menasha, Wis., 1947.

This survey of the effect of insecticides used on *Citrus* trees on beneficial insects under field conditions in California is based on observations in 1907–47. At the beginning of this period, when fumigation with hydrocyanic acid gas was the only treatment in general use and few orchards were treated annually, scale insects were the principal pests, with the citrus mealybug [*Pseudococcus citri*, Risso] and red spider [*Paratetranychus citri*, McG.] causing occasional damage. The black scale [*Saissetia oleae*, Bern.] was heavily attacked by *Scutellista cyanea*, Mots., in the egg stage and by *Rhizobius ventralis*, Erichs., in the immature stages, and *Aphytis chrysomphali*, Merc., was found in every orchard infested with the red scale [*Aonidiella aurantii*, Mask.] and sometimes gave good commercial control. Though neither the purple scale [*Lepidosaphes beckii*, Newm.] nor the yellow scale [*A. citrina*, Coq.] was attacked by important insects, *R. ventralis*, *Lindorus lophanthae*, Blaisd., *Chilocorus stigma*, Say (*bivulnerus*, Muls.) and species of *Scymnus* were widely scattered general scale feeders. *Pseudococcus* was everywhere controlled by predators, and *Paratetranychus* was also usually under natural control. On the whole, the insecticides used before 1917–22 had no important influence on the activity of parasites and predators, except possibly those of the mite.

With the introduction of white-oil sprays, the development of resistance in certain insects to particular insecticides, the introduction of double treatment with oil spray and fumigation and the increased care with which treatment was carried out, great destruction of natural enemies resulted. *Hyperaspis lateralis*, Muls., and *Rodolia koebelei*, Oliff, once both abundant, almost or completely disappeared, and *Orcus chalybeus*, Boisd., *Sympherobius barberi*, Banks, *S. californicus*, Banks, *Aphytis chrysomphali*, and species of *Scutellista* and *Rhizobius*, though still present, no longer gave effective control. The predators least affected by these treatments were species of *Chrysopa*, *Hippodamia* and *Coccinella* and Syrphids. The commercial liberation of large numbers of *Cryptolaemus montrouzieri*, Muls., also tended to suppress native predators. *Scutellista* and the introduced parasites, *Metaphycus lounsburyi*, How., and *M. helvolus*, Comp., which attack *Saissetia oleae*, persisted in spite of oil sprays and fumigation. *P. citri* became more important in the interior valleys than on the coast ; the reasons for this are not understood.

DDT has lately been used on *Citrus*. Dusting with 2 per cent. DDT in sulphur 3–4 times at the rate of 100 lb. per acre on grapefruit in central California in 1946 resulted in the heaviest infestation of the citricola scale [*Coccus pseudomagnoliarum*, Kuw.] for over 20 years, in spite of the fact that the unusual development of a second generation of the scale, and consequent presence of various sizes of scale throughout the summer, resulted in rapid development of parasites such as *Metaphycus* spp. and *Coccophagus* spp., which normally have only a limited season for effective parasitism, since they mainly attack the small scales. *Comperiella bifasciata*, How., which parasitised *Aonidiella citrina* heavily, was reduced in numbers by fumigation and possibly by sulphur, though females were observed to oviposit in scales covered with sulphur dust at a temperature of 105°F. without apparent disturbance, and is apparently killed by DDT, since *A. citrina* has increased rapidly in many orchards treated with DDT in central California. The soft brown scale [*Coccus hesperidum*, L.] is normally controlled by the parasites that attack *C. pseudomagnoliarum* and usually develops only in the presence of ants, mainly the Argentine ant [*Iridomyrmex humilis*, Mayr]. Heavy applications of sprays of 15 lb. 50 per cent. wettable DDT per 100 U.S. gals. water have temporarily increased established infestations, but such treatments have not caused serious

trouble with this scale. Treatment with arsenicals or DDT has sometimes resulted in heavy infestations of *Icerya purchasi*, Mask., by eliminating *Rodolia cardinalis*, Muls. The use of arsenicals on *Citrus* is now prohibited, and after commercial use for one year the application of DDT has been definitely restricted by the threat of further increases in *I. purchasi*.

Davis (E. W.) & Landis (B. J.). **Overwintering of Potato Flea Beetles in the Yakima Valley.**—*J. econ. Ent.* **40** no. 6 pp. 821–824, 6 refs. Menasha, Wis., 1947.

The following is based on the authors' summary. *Epitrix subcrinita*, Lec., and *E. tuberis*, Gentner, attack potatoes in the Yakima Valley, Washington, but have different overwintering habits, which preclude the development of a uniform method of cultural or insecticidal control during the winter. The overwintering habits of the two species were studied by means of wooden cages of various depths containing measured amounts of soil, plant litter or combinations of the two, in which known numbers of flea-beetles were put in the autumn. The suitability of the different media was estimated from the numbers of flea-beetles recovered in the spring. In cages containing plant litter, the average percentages of survival of *E. subcrinita* and *E. tuberis* were 30·5 and 13·2 respectively, whereas in cages containing soil they were 0·2 and 40·8, indicating that plant litter was essential for high survival of *E. subcrinita* and soil for *E. tuberis* and that the destruction of plant remnants in and round potato fields might be helpful in the control of *E. subcrinita* but not of *E. tuberis*. Differences in the numbers of each species recovered from depths of 3, 6 or 12 ins. in litter or soil were not significant. The vertical distribution of overwintering flea-beetles was investigated by confining them in autumn in a 30-inch column of soil covered lightly with plant litter ; 97 per cent. of *E. subcrinita* were found later in the winter in the top inch of soil and litter, whereas most examples of *E. tuberis* were at a depth of 9 ins. although some were found in each inch layer of soil above this level. The maximum depth of penetration was 21 ins. In a test on the effect of burial in the soil, both species emerged in considerable numbers from a six-inch layer of soil that had been buried beneath 24 ins. of soil. In preliminary tests, ploughing to bury the overwintering flea-beetles was of no value in reducing winter survival of either species.

Cowan (F. T.) & Shipman (H. J.). **Quantity of Food consumed by Mormon Crickets.**—*J. econ. Ent.* **40** no. 6 pp. 825–828, 2 graphs, 1 ref. Menasha, Wis., 1947.

The following is based on the authors' summary. The quantity of food consumed by examples of *Anabrus simplex*, Hald., was studied in the laboratory during the winter of 1936 and in the field during the spring and summer of 1941. The tests in 1941, in which lucerne leaves were used as food, showed that a single Tettigoniid requires 3,518 mg. of food in the four months from hatching until 20 days after reaching the adult stage. On this basis, a band covering a section (640 acres) of land at a density of ten per square yard would consume 120 tons of forage (dry weight) in four months, which is the quantity available on 4·4 sections of range land in northern Nevada if pastured to capacity, or the quantity estimated to be required for the adequate pasturage of 44 head of cattle for nine months. An adult population as low as 0·3 per square yard over a section of range land would eat as much as ten head of mature cattle, and one acre of adults at 25 per square yard could ruin a ton of lucerne hay in 32 days.

Schmidt (C. T.). **Dispersion of Fumigants through Soil.**—*J. econ. Ent.* **40** no. 6 pp. 829–837, 11 figs., 8 refs. Menasha, Wis., 1947.

Soil fumigation has been limited in the past by its high cost, but with the development of D-D mixture, which is cheap, reconsideration of this method of treatment has become necessary, and in this paper, the author describes experiments on the diffusion of chlorpicrin and D-D vapours through soil masses. Since commercial D-D mixture, though described as a mixture of 1,2-dichlorpropane and two isomers of 1,3-dichlorpropene, also contains trichlorides and other fractions with higher boiling points, so precluding the use of a single analytical method, and since even standard chemical methods require samples of considerable volume, which if drawn at intervals from the soil interfere with normal diffusion and therefore produce unreliable results, a biological assay method was devised and tested in Hawaii to indicate the presence of fumigant vapours and give a rough quantitative measure of the concentration of gas. Adults of *Calandra* (*Sitophilus*) *oryzae*, L., which are unusually sensitive to low concentrations of gas, are little affected in their reaction to gas by atmospheric humidity and do not require food during the observation period, were used as the test insects; a definite relation exists between the percentage mortality of this weevil, exposure time and vapour concentration. The soil for the experiments was typical lateritic pineapple soil from Wahiawa, Oahu, and it was put in a wooden box 24 ins. deep and 48 ins. square. Wire cages containing 40 weevils were placed above the point of injection and at lateral distances of 6, 12 and 18 ins. from the vertical injection axis and at depths of 1, 6, 12 and 18 ins., and the liquid fumigant was introduced at a depth of 6 ins. The weevils were exposed in the soil for five hours and then replaced by others. They were kept for another 24 hours to overcome any effects of anaesthesia before mortality was determined.

The following is based on the author's summary. The concentrations of chlorpicrin and D-D vapours in the soil were high initially and then diminished slowly. Chlorpicrin was more efficient in dispersion and was retained in the soil for longer than D-D mixture, though there is apparently no correlation between these characteristics and the efficiency of the materials as partial sterilising agents [*cf. R.A.E.*, A **34** 135]. Vapour movement was most rapid in soil of medium moisture content, less rapid in dry soil and least rapid in very wet soil. The retention time of the vapours in the soil increased in the same order. Increasing the depth at which the fumigants were applied to 12 ins. extended the retention time of the vapours but apparently reduced their efficiency near the soil surface, particularly in the case of D-D mixture.

Doucette (C. F.). **Host Plants of the Cabbage Seedpod Weevil.**—*J. econ. Ent.* **40** no. 6 pp. 838–840. Menasha, Wis., 1947.

The following is based on the author's summary. Three types of feeding occur in the life-cycle of *Ceuthorrhynchus assimilis*, Payk. Before hibernation, the adults feed on thick green parts of wild and cultivated crucifers of the genera *Brassica* and *Raphanus* and cause some seed damage by feeding on immature pods. After hibernation, the adults feed primarily on nectar, largely in flowers of the same plants, but also in those of other crucifers. They also bore in unopened buds, and the females make holes in the pod walls in which to oviposit. The third type of feeding is that of the larvae, which feed on the seeds developing within the pods.

In studies made in western Washington and Oregon, larval attack was found only on plants of the genera *Brassica* and *Raphanus*. In tests with various species and varieties, the numbers of larvae per 100 pods varied widely. Infestation was much lower in radish pods than in cultivated forms of *Brassica*, but caused considerable damage to the seed. *B. juncea* (Indian mustard) and

B. campestris (wild turnip) were both attacked moderately. The widespread occurrence of the latter and the somewhat localised occurrence of *R. raphanistrum* (wild radish) are important factors in the spread of the weevil and the maintenance of populations in areas where there is no commercial seed production of susceptible food-plants. Varieties of cabbage differed in susceptibility. Kohlrabi was also attacked, but the larvae appeared to be unable to complete their development in pods of this plant.

DAHMS (R. G.). **Oviposition and Longevity of Chinch Bugs on Seedlings growing in nutrient Solutions.**—*J. econ. Ent.* **40** no. 6 pp. 841–845, 4 refs. Menasha, Wis., 1947.

The following is based on the author's summary of this account of investigations carried out in Oklahoma in 1940 and 1941 on the effect of salts containing phosphorus, nitrogen and other plant nutrients on the oviposition and length of life of *Blissus leucopterus*, Say, on two varieties of sorghum [*cf.* *R.A.E.*, A **29** 258]. Finney milo and Atlas sorgo plants were grown for eight or twelve days in various nutrient solutions, after which adult bugs were caged on them. Under these conditions, the bugs laid more eggs on plants growing in solutions high in nitrogen or low in phosphorus than on the same varieties growing in solutions that were low in nitrogen or high in phosphorus. The differences were not nearly so great, however, as between the two varieties of plants growing in the same solutions, Atlas sorgo proving much less favourable than Finney milo [*cf.* **37** 224]. The length of life of females feeding on Atlas sorgo did not appear to be affected by the nature of the nutrient solution, but was considerably reduced on plants growing in distilled water. None of the bugs feeding on this variety lived so long as those feeding on Finney milo. First-generation females feeding on Finney milo growing in distilled water lived longer than those feeding on plants growing in any of the solutions. As many eggs were laid by these bugs as were laid on plants growing in the high-chlorine solution, and almost as many as were laid on plants growing in high-phosphorus and low-nitrogen solutions. This indicated that Finney milo seed contained suitable nutrients, so that the seedlings were favourable for chinch-bug development. In general, females lived longer on Finney milo growing in the solutions that induced a comparatively low rate of oviposition. On plants growing in most solutions in which the nitrogen-phosphorus ratio was low, the total and average daily egg deposition per female was low, but where this ratio was high the bugs did not always lay a large number of eggs. During the first 30 days, first-generation bugs feeding on Finney milo growing in low-phosphorus or high-nitrogen solutions usually laid many more eggs than those on plants growing in high-phosphorus or low-nitrogen solutions. During the next 10–15 days, about equal numbers of eggs were laid on plants in all solutions, and thereafter the bugs often laid slightly more eggs on the high-phosphorus or low-nitrogen plants.

FLEMING (W. E.) & MAINES (W. W.). **Control of Vineyard Insects with DDT, with special Reference to the Japanese Beetle and the Grape Berry Moth.**—*J. econ. Ent.* **40** no. 6 pp. 845–850. Menasha, Wis., 1947.

Preliminary tests in an isolated vineyard in New Jersey early in August 1943 indicated that DDT was promising for the control of *Popillia japonica*, Newm., provided that it could be used in a programme that would also control *Polychrosis viteana*, Clem., and black rot caused by *Guignardia bidwellii*, and further experiments were therefore carried out in the same vineyard in 1944–46. In 1944, cultural measures were used against *P. viteana* and disease. These comprised burning the prunings from the vines, eliminating weeds from the

trellis strips by burning, cutting and cultivation, and pulling out and turning over the ridged trellis strips early in spring to bury the mummified fruit and old leaves; the furrows were thrown back later to restore the ridge in the trellis strips. In this vineyard there appeared to be at least two generations of *P. viteana* a year. Larvae of the first appeared in June, during and after blossoming, and fed in the blossoms and newly formed berries, and those of the second attacked the maturing fruits in late July and August. In view of the difficulty of obtaining adequate coverage of the fruit in midsummer, because of the protecting canopy of leaves, and the danger of building up an excessive residue on the fruit, it was hoped to control *P. viteana* by means of sprays against the first generation only. All sprays were applied at the rate of 250–300 U.S. gals. per acre by means of a covered U-boom with 16 nozzles directed at the top and both sides of the row; the sprayer moved at 5–10 miles per hour.

The following is based on the authors' summary. It was found that three sprays of 1 lb. DDT in 100 U.S. gals. Bordeaux mixture, applied just before blossoming, at petal fall and when the grapes were the size of peas, controlled *P. viteana* and protected the vines from attack by *Popillia japonica* until the middle of July. An additional spray containing ½ lb. DDT per 100 U.S. gals. protected the fruit and foliage from the beetle for the remainder of the season. These sprays also controlled *Macrodactylus subspinosus*, F., and *Erythroneura* spp., but had little effect on *Aphis illinoisensis*, Shimer, *Pseudococcus maritimus*, Ehrh., or *Lasioptera vitis*, O.-S. Mites did not occur in this vineyard. The DDT sprays did not injure the fruit or foliage, and indications were obtained that residues from them accumulating in the soil would not involve a risk to the life of the vines. DDT residues on the grapes 2–4 weeks before harvest were well below 7 parts per million [*cf. R.A.E.*, A **35** 110] when no oil was used and above it when oil was used as an adhesive. Black rot was prevalent throughout the vineyard in 1943, but became less so in 1944 and 1945 and was practically eliminated by 1946. It was evident that the cultural measures used and the more thorough and carefully timed sprays were factors in controlling it.

KULASH (W. M.). **Soil Treatment for Wireworms and Cutworms.**—*J. econ. Ent.* **40** no. 6 pp. 851–854, 3 refs. Menasha, Wis., 1947.

Wireworms are frequently reported as pests of agricultural crops in various sections of North Carolina, and cutworm injury has been severe in nearly all parts of the State. The principal cutworm injuring maize seedlings in the Wilmington area is *Agrotis ypsilon*, Hfn., the very young larvae cutting the seedlings above the soil surface and the older ones either at the surface or just below it. The wireworms responsible for most of the damage to maize are *Conoderus bellus*, Say, and *C. auritus*, Hbst.; they completely riddle the germinating seed or bore through the stems of seedlings just below the soil surface, sometimes killing the plants.

Experiments are described in which attempts were made to find a soil insecticide that would control both wireworms and cutworms with a single treatment. In the first, suspensions and dusts of DDT and benzene hexachloride, and D-D mixture (dichlorpropane and dichlorpropene [*cf. R.A.E.*, A **37** 290]), were applied at various rates in two-foot strips along the rows of maize. The dusts were broadcast and mixed with the top two inches of soil before the maize was sown, and the liquids were applied immediately after sowing. Examination of the plots within 30 minutes of treatment showed no insect activity except in one of the plots treated with a suspension of wettable benzene hexachloride (1 per cent. γ isomer). Three weeks later, the plots treated with 10 per cent. DDT dust showed the greatest numbers of plants, and 100 lb. dust per acre was apparently no more effective than 10 lb. per acre.

Treatment with suspensions of DDT at 200 and 400 lb. 50 per cent. wettable powder per acre resulted in slower germination than 40 or 80 lb. and retarded plant growth. Benzene-hexachloride dusts containing 1 per cent. γ isomer, applied at 100–1,000 lb. per acre, and the suspension at 0·4–4 lb. γ isomer per acre were no more effective than 10 or 50 per cent. DDT dusts at 10–100 and 50–400 lb. per acre, respectively, or 50 per cent. wettable DDT at 40–400 lb. per acre. The benzene-hexachloride dust did not materially affect germination, but the suspension did in some cases, and over 70 per cent. failure was observed in the plots treated with D-D mixture at 50–1,000 lb. per acre.

In the second experiment, DDT dust diluted with sand to contain 5 per cent. DDT was applied directly to the soil surface in a band 2 ins. wide at a distance of 1–2 ins. from the rows of seedling maize at the rate of 500 lb. mixture (25 lb. technical DDT) per acre. Examination three hours after treatment showed that ground beetles, click beetles and larvae of *A. ypsilon* were affected, and 15 hours after treatment these cutworms as well as several ground beetles, crickets and grasshoppers were found dead. Older larvae of *A. ypsilon* and wireworms were not controlled.

PARKER (R. L.) & ESHBAUGH (E. L.). **Codling Moth and Mite Control in Kansas with new Insecticides.**—*J. econ. Ent.* **40** no. 6 pp. 861–864. Menasha, Wis., 1947.

In 1945 and 1946, comparative tests of lead arsenate, [14 per cent.] fixed nicotine (Black Leaf 155) and some of the newer insecticides to control the codling moth [*Cydia pomonella*, L.] and prevent infestations of the two-spotted mite [*Tetranychus bimaculatus*, Harvey] on apple were carried out in Kansas. All trees received a calyx spray of lead arsenate, followed by eight cover sprays timed by bait-traps in 1945 and 7–9 in 1946. All spray quantities are given per 100 U.S. gals. spray.

A combination of 7 per cent. fixed nicotine and 17 per cent. DDT applied at 3 lb. in the first cover spray, 2 lb. with 2 U.S. quarts oil emulsion in the next four and 2 lb. with 3 U.S. pints oil emulsion in the last three gave 96·5 per cent. clean fruit in 1945, and one of 12 per cent. fixed nicotine and 7 per cent. DDT (Black Leaf 155X) applied at 3 lb. in the first two and at 2 lb. with 1 U.S. quart oil emulsion in the other seven gave 98·5 per cent. clean fruit in 1946. Eight cover sprays of 1 lb. 40 per cent. DDT gave only 85·2 per cent. clean fruit in 1945, but seven of 2 lb. 50 per cent. DDT gave 98·2 per cent. in 1946. Programmes of 4 lb. lead arsenate, alone or with 4 oz. zinc sulphate and 1 U.S. quart oil emulsion (in the first 5–6 sprays) were about equally effective against *C. pomonella* in both years; the former resulted in 81·1 and 88·1 per cent. clean fruit and the highest number of superficial injuries of any spray combination tested, and the latter in 95·4 and 95·7 per cent. clean fruit. Schedules of Black Leaf 155 at 3 lb. in the first spray and 2 lb. in the other seven in 1945 and at 3 lb. in the first two and 2 lb. in the other seven in 1946, with oil emulsion in some of them, gave 93·2 and 93·6 per cent. clean fruit, respectively. In 1946, schedules of 2 lb. 50 per cent. di(methoxyphenyl)-trichlorethane [methoxy-DDT] or 2 lb. 50 per cent. benzene hexachloride (5 per cent. γ isomer) in seven sprays or of 2 lb. 50 per cent. DDT in the first three sprays and 5 lb. of a mixture containing 16·66 per cent. DDT and 20 per cent. hydroxypentamethylflavan (against mites) in the other four were also used. The benzene-hexachloride spray gave only 43·9 per cent. clean fruit, but the other two combinations gave 96·1 and 94·1 per cent. The high level of control obtained in 1946 is attributed to proper timing of sprays and to

spraying the remainder of the orchard round the plots with a mixture of DDT and lead arsenate.

At harvest, apples that had been sprayed with 40 or 50 per cent. DDT had DDT residues over the unofficial tolerance of 0·049 grain per lb. fruit [*R.A.E.*, A **35** 110], but those sprayed with DDT, fixed nicotine and summer oil emulsion, DDT and hydroxypentamethylflavan or methoxy-DDT had residues below it.

Mites did not become sufficiently numerous to injure foliage on any trees but those treated with 40 per cent. DDT and lead arsenate alone in 1946. The mixture of DDT and hydroxypentamethylflavan prepared for mite control proved effective. One half of a tree that was not included in the test plots and showed severe mite injury, with populations of up to 160 mites and 120 eggs per leaf, was sprayed with it on 19th July, and counts on 24th July showed that the numbers of mites per leaf had decreased to 5 or less on the sprayed part and increased to more than 200 on the unsprayed part. Most of the leaves had dropped from the unsprayed portion of the tree by 22nd August, whereas the population on the sprayed portion was never big enough to cause much injury to the leaves, which remained green until killed by frost, although some increase of mites occurred.

ARMITAGE (H. M.). **The Mexican Bean Beetle in California.**—*J. econ. Ent.* **40** no. 6 pp. 865–869. Menasha, Wis., 1947.

The author describes the discovery of *Epilachna varivestis*, Muls., on beans in California and the attempts made to eradicate it in 1946 [*R.A.E.*, A **36** 396]. Subsequent investigations showed that the beetles overwintered on the soil beneath loose ground litter under eucalyptus, walnut or lemon trees in windbreaks or orchards near the infested fields but not under cypress windbreaks, where the soil was drier. Beginning on 1st February 1947, the litter under all eucalyptus windbreaks was raked and burnt and the exposed ground was sprayed with pyrethrum (1 : 400), which was toxic to the adults in laboratory tests. At the same time, about 800 acres of walnut and lemon orchards adjacent to infested fields were double disked and cleared of ground litter near the trees, and all weeds between infested fields and along roads were sprayed with oil. It was hoped to plant trap-crops along the margins of infested fields on 1st March, before the beginning of commercial spring planting (usually about 1st May), but owing to unseasonable dry weather this could not be done until late April. By 1st June, 37 per cent. of the beetles in a controlled hibernation cage had resumed activity, and 15 scattered adults had been found in the trap-crops and earlier commercial plantings in fields that had been heavily infested in the previous season. Three egg-masses and a few plants showing fairly heavy adult feeding were also found, but no larvae were observed. All insects and eggs were collected and destroyed as soon as found, the infested plants were pulled up and burned and all plants within 50 feet of them were dusted with 1 per cent. rotenone. Field dusting with 1 per cent. rotenone applied by power ground machines was begun at about the same time, and by 15th June all fields known to have been infested had been dusted once and a second application had been begun. There were not enough insects of any stage to determine the effectiveness of the increased rotenone concentration, but no more effective material was discovered. Ecological studies revealed no additional native plants that were acceptable to the beetle. It is stated that for fumigating harvesting equipment under ordinary canvas with hydrocyanic acid gas, 1½ oz. sodium cyanide or its equivalent [per 100 cu. ft.] for one hour at temperatures above 50°F. was found effective and authorised [*cf.* **36** 397].

Yust (H. R.), Nelson (H. D.), Busbey (R. L.) & Fulton (R. A.). **Influence of various Exposure-Concentration Combinations on Mortality of the California Red Scale in HCN Fumigation.**—*J. econ. Ent.* **40** no. 6 pp. 869–874, 1 fig., 10 refs. Menasha, Wis., 1947.

When *Citrus* trees infested by *Aonidiella aurantii*, Mask., are fumigated with hydrocyanic acid gas under canvas tents, the exposure is usually limited to 45–50 minutes, since most of the gas escapes within an hour, but when more nearly gas-tight coverings are used, appreciable concentrations remain at the end of 45 minutes. The influence of the duration of exposure and other factors on the kill of scales in fumigation with HCN was therefore investigated in laboratory and field tests.

The following is based on the authors' summary. Examples of a resistant strain of *A. aurantii* were fumigated in the laboratory with different concentrations of HCN for different periods such that the product of average concentration and time was constant. The treatments included exposure to both constant and decreasing concentrations, with and without prefumigation exposure to sublethal dosages that produced stupefaction. In tests with decreasing and constant concentrations applied to scales that had not been subjected to prefumigation, the kills were generally directly proportional to the concentrations when the products of concentration and time were the same. In similar tests after prefumigation, the direct correlation between concentration and kill disappeared. The results suggest that protective stupefaction may occur during fumigation with lower concentrations and longer exposures. In three of four tests with prefumigation, somewhat better kills were obtained with 90-minute exposures than with 15-minute exposures with equivalent combinations of time and concentration. No adequate explanation of this was found.

In 15-minute exposures, the kills for constant and decreasing concentrations were approximately equal in tests with mature females and scales in the second moult, with and without prefumigation. In 90-minute exposures without prefumigation, higher kills of both stages were obtained with decreasing than with constant concentrations, and with the same exposure after prefumigation, higher kills of scales in the second moult but not of mature females were obtained with decreasing than with constant concentrations. These data indicate that protective stupefaction resulted from the final constant concentrations in the 90-minute exposures, except in the case of mature females that had been prefumigated.

In three field tests with regular duck tents, the kills were approximately the same at the end of 25 minutes as at the end of 45 minutes. The dosage for 25 minutes, as judged by the product of concentration and time, was 86·6 per cent. of the dosage for 45 minutes. It was over 86·5 for one-third of the 211 trees fumigated. With plastic-coated coverings, which were semi-gastight, the kills were significantly higher after 45-minute exposures than after 25-minute exposures to equivalent concentrations.

Gunther (F. A.). **Thermal Decomposition of DDT and Benzene Hexachloride Mixtures.**—*J. econ. Ent.* **40** no. 6 pp. 874–877, 10 refs. Menasha, Wis., 1947.

The presence of iron has been shown to induce or accelerate the thermal dehydrohalogenation of DDT [*cf. R.A.E.*, A **37** 285] and although published data indicate that the chloride ion is not a catalyst for this process and hydrogen chloride only doubtfully so, it is possible that the addition to DDT of substances that are capable of liberating hydrogen chloride might catalyse the thermal decomposition of the DDT. One such substance is benzene hexachloride, and the behaviour of the technical material and of the four

predominant isomers alone and with DDT under conditions conducive to the decomposition of the latter was investigated.

When samples of technical DDT and p,p′ DDT were kept for 24 hours at 110–120°C. [230–248°F.] in the presence of 2–3 per cent. ferric iron as ferric nitrate, decomposition was complete (114·5 and 110·5 per cent. dehydrohalogenation, based on the number of gram molecules of chloride ion per gram molecule of original compound) whereas decomposition at the same temperature without the iron was negligible (0·4 and 0 per cent. dehydrohalogenation after 93–96 hours). Benzene hexachloride was also resistant to heat alone, the four isomers showing 0·07, 0, 0·07 and 0 per cent. dehydrohalogenation, respectively, after about 24 hours at 110–120°C., though the technical material appeared to contain minute traces of a catalytic or other substance that tended to accelerate decomposition slightly (0·25 per cent. in 24 hours). The addition of 2–3 per cent. ferric iron resulted in 0·32, 0·39, 0·36 and 0·15 per cent. dehydrohalogenation of the α, β, γ and δ isomers, respectively, and in 0·76 per cent. of the technical material after 24 hours. Although the effect of adding iron was practically negligible, it was apparent that the β and δ isomers were the most stable and that the α and γ isomers possessed equal but somewhat lower stabilities, the δ isomer being the most resistant of all to the effect of added iron. The smaller increase in the rate of thermal decomposition of the technical material was apparently due to traces of catalysing substances already present in it.

When equal quantities of DDT and benzene hexachloride were mixed intimately and heated as before, the percentages of dehydrohalogenation after about 24 hours were 82·8, 81·8, 89·8 and 88·1 for p,p′ DDT with the α, β, γ and δ isomers, 94·6 for p,p′ DDT with technical benzene hexachloride, and 103·2 for technical DDT with technical benzene hexachloride. When ferric nitrate was added, the corresponding percentages were 56·2, 116·4, 132·2, 136·4, 126·2 and 129·9, showing that except in the case of the α isomer, which showed an unexplained reduction, the addition of ferric iron caused an average of 37·5 per cent. increase in decomposition in 24 hours, and that benzene hexachloride caused 16 per cent. increase in the effective iron-catalysed decomposition. Comparison with the data from uncatalysed decomposition indicates that secondary decompositions of the DDT were possibly implemented to produce this effect.

In tests in which 1 gm. samples of iron-free p,p′ DDT were kept in sealed tubes at 110°C. with dry air, 1 ml. aqueous hydrochloric acid or anhydrous alcoholic HCl (11 per cent. solutions), anhydrous HCl gas or 1 gm. chlorbenzene for 24 hours, or with 80 ml. saturated solution of zinc chloride or zinc sulphate in ethyl acetate for two hours, the percentages of dehydrohalogenation were 0, 7, 0, 0, 54, 0 and 0, and it is concluded that the decomposition of DDT is not catalysed by the chloride ion or by hydrogen chloride.

Hsing Yun Fan. **The Toxicity of Organic Arsenicals.**—*J. econ. Ent.* **40** no. 6 pp. 883–895, 58 refs. Menasha, Wis., 1947.

The following is substantially the author's summary. Sixty-one organic arsenic compounds were mixed with flour or an inert diluent and tested for stomach and contact toxicity against adults of *Tribolium confusum*, Duv. The effective poisons among them were graded according to their lethal properties as measured by the time required for a 50 per cent. kill. It was found that meta-chlorphenylarsonic acid, phenylarsonic acid, 2-amino-1-naphthalenearsonic acid and a few others showed very promising insecticidal properties and were comparable with some of the best insecticides in current use.

The relationship between the structure and toxicity of these arsenicals has been formulated tentatively. In the phenylarsonic acid series, the meta-substituted compounds were generally more effective than their corresponding ortho- and para-isomers. In the nitro- and aminonaphthalenearsonic acid series, the compounds were usually more effective when the amino or the nitro group was on the ring containing the arsono group.

GAINES (J. C.). **Tests of Insecticides for Control of Grasshoppers.**—*J. econ. Ent.* **40** no. 6 pp. 896–899, 5 refs. Menasha, Wis., 1947.

The results are given of laboratory and field tests carried out near College Station, Texas, in the spring of 1947 in an attempt to develop more effective and economical methods of controlling grasshoppers in this area. Mixed populations of grasshoppers were found, but the majority were *Melanoplus differentialis*, Thos. Hatching was considered to be complete by 5th May, when the first field test was begun. Nymphs that had not reached the fifth instar were used in all tests. When they were caged with cotton plants that had been dusted with different insecticides an hour before, 10 per cent. chlordane gave higher mortality than 3 per cent. γ benzene hexachloride, alone or with 5 per cent. DDT, or than 10 per cent. toxaphene or 1 per cent. aryl alkyl thionophosphate [parathion]. Although the nymphs came in contact with the materials, it is assumed that these acted principally as stomach poisons. When the nymphs were dusted and put in cages containing clean cotton plants, to test the contact effect of the insecticides, 3 per cent. γ benzene hexachloride was much the most effective, and 10 per cent. chlordane and 1 per cent. aryl alkyl thionophosphate were more toxic than 15 per cent. toxaphene.

In a field test on weeds, in which the initial infestation of nymphs averaged 77 per 50 sweeps, baits containing 6 lb. 50 per cent. toxaphene emulsion or 6 lb. 50 per cent. wettable chlordane per 100 lb. bran and sawdust (1 : 3) were more effective (62 per cent. average mortality) than those containing 6 lb. sodium fluosilicate or wettable benzene hexachloride (7·5 per cent. γ isomer) per 100 lb. (40–45 per cent. mortality), when applied once at 10 lb. and once at 20 lb. per acre. A 20 per cent. toxaphene dust, and sprays of chlordane and toxaphene applied at the rate of 2 lb. and 1 lb. toxicant per acre, respectively, gave 91·6, 93·6 and 76·4 per cent. mortality. In another test on weeds in which the initial infestation averaged 104 nymphs per 50 sweeps, dusts of 5, 10 and 15 per cent. toxaphene, applied with ground machines at 9·2–14 lb. per acre caused averages of 67·7, 34·8 and 61·6 per cent. mortality, and one of 20 per cent. toxaphene applied at 30·8 lb. per acre caused 82·4 per cent. Dusts of 3 per cent. γ benzene hexachloride, alone and with 5 per cent. DDT, and 5 per cent. chlordane, applied at 11·2, 20 and 11·6 lb. per acre, gave 66·1, 88·2 and 47·7 per cent. mortality, and one containing 75 per cent. calcium arsenate and 10 per cent. toxaphene at 12 lb. per acre gave 76·8 per cent. mortality. The 10 per cent. toxaphene dust was more effective when applied from an aeroplane, giving 87·4 per cent. mortality. In a test on lucerne, in which the initial infestation averaged 364 nymphs per 50 sweeps, dusts containing 10 per cent. toxaphene, 5 per cent. chlordane and 3 per cent. γ benzene hexachloride, applied at 12·8, 22·4 and 10·4 lb. per acre, respectively, all gave effective control in three applications, although the first two were washed off by rain within 30 hours and there was a heavy migration from neighbouring lucerne, resulting in about 500 per cent. increase in population on an untreated plot, when it was cut on the day of the second application. A dust containing 10 per cent. toxaphene and 75 per cent. calcium arsenate was just as effective, but little is known about the possible breakdown of toxaphene when it is mixed with a highly alkaline material.

Considerable areas of weed fields, hedgerows and edges of lucerne and cotton fields were dusted with toxaphene and benzene hexachloride by aeroplane or ground machinery. The treatments were effective and prevented damage to cultivated crops. When the grasshopper populations were high, 1·5–2 lb. toxaphene or 0·3 lb. γ benzene hexachloride per acre was necessary for adequate control. The effectiveness of benzene hexachloride was greatly reduced by wind drift.

Poos (F. W.), Grayson (J. M.) & Batten (E. T.). **Insecticides to control Tobacco Thrips and Potato Leafhopper on Peanuts.**—*J. econ. Ent.* **40** no. 6 pp. 900–905, 9 refs. Menasha, Wis., 1947.

Frankliniella fusca, Hinds, and *Empoasca fabae*, Harr., are important pests of groundnuts in south-eastern Virginia, and in 1945 and 1946, control experiments were carried out at Holland, Virginia, against both insects and at Beltsville, Maryland, against the thrips.

The following is based on the authors' summary. Adequately replicated tests carried out on small plots with hand-operated equipment showed that the thrips can be satisfactorily controlled on seedling groundnuts with three applications of DDT, or probably fewer if they were properly timed. The best results were obtained with an emulsified solution containing 4 per cent. DDT applied by atomisation at the rate of about 10 U.S. gals. per acre. Differences in yield between treated and untreated plots were significant where the tests were made on soils of low fertility, but not in similar plots on more fertile soil. Plants grown in soil of low fertility appeared to be slower in recovering from thrips injury than those in more fertile soil. Residues of DDT on hay samples collected at harvest in 1946 did not exceed 4·5 parts per million, except when additional applications of a dust containing 2 per cent. DDT in pyrophyllite were made during July and August to control the leafhopper. Further investigations are needed to determine the losses in yield of field-cured groundnuts and groundnut hay caused by the thrips, especially when the crop is grown on soils of average or less than average fertility in the commercial groundnut-growing area of Virginia, and to determine the minimum amount of DDT required to control this insect satisfactorily on groundnuts, the best formulations to use, the best number and timing of applications, the most feasible method of application and the residues to be expected from such treatments.

The results of field tests against the leafhopper in Virginia indicated that plots treated with dusts containing DDT and sulphur (in both fused and mechanical mixtures) failed to give significant increases in yields of field-cured groundnuts and groundnut hay, although some increase in yields from the treated plots was indicated. Satisfactory reductions in population were obtained with concentrations of DDT as low as 1 per cent. in sulphur, applied at the rate of 20–25 lb. per acre three times at intervals of about three weeks during July and August. It seems probable that greater differences in yield would be obtained in more normal seasons and that sulphur alone could be used for the third application. Unusually heavy rainfall occurred during the growing season of 1945, and in 1946 populations of *E. fabae* were the lowest ever recorded in the Holland area. The highest amount of DDT reported on hay samples collected at harvest was 28·3 p.p.m., and this resulted from three applications of a fused mixture of 5 per cent. DDT in sulphur. Residues at harvest on plants treated with three applications of sulphur containing 1 and 2 per cent. DDT did not exceed 4·5 p.p.m. Although these results are encouraging, more tests are needed before DDT can be recommended for use on groundnut forage that will be fed to livestock.

McAlister jr. (L. C.), Jones (H. A.) & Moore (D. H.). **Piperonyl Butoxide with Pyrethrins in wettable Powders to control certain Agricultural and Household Insects.**—*J. econ. Ent.* **40** no. 6 pp. 906–909, 7 refs. Menasha, Wis., 1947.

Since piperonyl butoxide, which is the technical grade of (3,4-methylenedioxy-6-propylbenzyl) (butyl) diethylene glycol ether, has given excellent results as a synergist with pyrethrins in petroleum oil sprays, liquefied-gas aerosols and powders or dusts against the usual household insects and certain agricultural insects, it was employed in wettable or water-dispersible powders in tests against house-flies [*Musca domestica*, L.] and flies on cattle [*cf. R.A.E.*, B **37** 155] and adults of the Japanese beetle [*Popillia japonica*, Newm.] on sweet maize in Maryland.

A wettable powder containing 2 per cent. piperonyl butoxide, 0·2 per cent. pyrethrins and 12·5 per cent. DDT was prepared as a suspension in water at a concentration of 16 lb. per 100 U.S. gals., and applied to maize silks that were being severely attacked by *P. japonica* at the rate of 1 U.S. gal. dilute suspension per 100 linear feet of row. Before treatment the silks on 90 per cent. of the ears were being so severely eaten that successful pollination could not have been completed, but 24 hours after spraying, hundreds of dead beetles were on the ground under each row and all the ears in the sprayed plots were free of beetles. Although the insect was at the height of its prevalence in the area, the treated maize remained free of beetles for a week, which was sufficient to permit completion of pollination and the production of a good crop. When beans on the margins of maize fields, grape vines and weeds were treated with the same spray, the initial application killed all the beetles present, and no others became established on the sprayed plants for nine days, although light to heavy rainfall occurred on several days and unsprayed plants in the same area were practically defoliated.

Tenhet (J. N.). **Effect of sublethal Dosages of Pyrethrum on Oviposition of the Cigarette Beetle.**—*J. econ. Ent.* **40** no. 6 pp. 910–911. Menasha, Wis., 1947.

In the course of extensive experiments with sprays of pyrethrum in oil in tobacco warehouses at Richmond, Virginia, in 1940–45, it was observed that adults of *Lasioderma serricorne*, F., that had survived exposure to the sprays did not deposit so many eggs as unsprayed examples, and records were therefore kept of the egg deposition of sprayed and unsprayed beetles in 1941, 1944 and 1945. During spray tests, wire cages containing 25–100 laboratory-reared beetles thought to represent constant proportions of the two sexes were exposed in the warehouse at points chosen at random, and the beetles subsequently removed to the laboratory and supplied with small sections of the split midrib of a tobacco leaf, in which the females oviposited. The numbers of eggs laid by sprayed and unsprayed beetles were compared on the basis of the number of surviving beetles in each cage, and the results of 51 tests in different warehouses or at different dates showed that beetles surviving exposure to a spray of pyrethrum in oil deposited 25–68 per cent. fewer eggs than untreated ones.

It is concluded that since surviving beetles deposited only about half the normal number of eggs, the control of *L. serricorne* in the warehouses was consistently better than was indicated by the mortality data from samples of test insects.

White (R. T.). **Milky Disease infecting *Cyclocephala* Larvae in the Field.**—*J. econ. Ent.* **40** no. 6 pp. 912–914, 6 refs. Menasha, Wis., 1947.

In the course of surveys in the United States in connection with studies of type A and type B milky disease, caused by *Bacillus popilliae* and *B. lentimorbus*,

respectively, in larvae of *Popillia japonica*, Newm., numerous instances of infection with similar organisms were recorded in other Lamellicorn larvae [*cf. R.A.E.*, A **30** 122]. In this paper, the author presents verified records of infected larvae of the genus *Cyclocephala* found in the field in 1938–46, making no attempt to separate the larval forms of *C. borealis*, Arr., and *C. immaculata*, Ol., though it is probable that most of the records refer to *C. borealis*. He tabulates 30 localities, in eight eastern States and the District of Columbia, in which infected larvae were found, showing the numbers collected and the dates. In most instances the causal agent was an organism similar to that which causes type A milky disease ; the disease was originally designated as atypical type A, but has more recently been called type A (*Cyclocephala* strain).

From the number and range of the collection points, it seems probable that organisms causing milky diseases among *Cyclocephala* larvae are rather common. Although no detailed study has been made to determine their effectiveness as a control for *Cyclocephala* and other native white grubs in the field, one observation is of interest. In the autumn of 1941 a heavy larval population of *P. japonica* and enough larvae of *C. borealis* to cause severe injury to turf were found in an area in the District of Columbia. Gross examination showed about 17 per cent. of these larvae to be affected by milky disease, and microscopic examination showed that the larvae of *P. japonica* were infected with type A and those of *C. borealis* with atypical type A, indicating that both organisms were present and acting independently. Many of the *Cyclocephala* larvae were also parasitised by an undetermined species of Hymenoptera. In October, about 12 per cent. of the *C. borealis* larvae were diseased, and by the following spring few could be found ; no concentrated larval population has since occurred in this area. It seems possible, therefore, that milky disease may be controlling sporadic infestations of *Cyclocephala* in many places.

Questel (D. D.) & Connin (R. V.). **A chemical Treatment of Soil which produces Plant Tissue lethal to European Corn Borer.**—*J. econ. Ent.* **40** no. 6 pp. 914–915. Menasha, Wis., 1947.

In the course of experiments begun in the United States in 1944 to find a chemical that could be applied to the soil when maize is planted or during the growing season and be taken up into the stalk and leaves to protect the plants from attack by *Pyrausta nubilalis*, Hb., some promise was shown by several compounds, but the most striking results were obtained in preliminary tests in 1947 with O,O-diethyl O-paranitrophenyl thiophosphate [parathion].

On 19th May, kernels of maize were planted in five-inch pots in soil that had been mixed with 2 gm. parathion per pot. The plants were grown in an unheated greenhouse, and after three weeks, when they were 6–8 ins. high, leaves and stems were cut into one-inch sections and put in test tubes with egg-masses of *P. nubilalis*. The newly hatched larvae fed very little on material from treated plants, and the mortality was 94 and 99 per cent. after 24 and 48 hours, respectively, on the leaves and 100 per cent. after 24 hours on the stems, whereas larvae fed readily on leaves and stems from untreated plants with not more than 3 per cent. mortality. Since the leaf sections were taken from points well above the surface of the soil and no insecticide was applied after sowing, it appears more likely that the toxic agent was taken up through the plant roots than that the leaves and stems bore any of the insecticide on their surface. When plants 3–4 ins. high were watered with a suspension of about 2 gm. parathion per plant, sections taken from the leaves and stalks one week later caused 5 and 96 per cent. mortality, respectively, as compared with 3 per cent. on untreated material, and sections taken from both two weeks after treatment caused 100 per cent. mortality, as compared with 0 and 11 per cent. on untreated material. The difference in toxicity of the leaves and stems

after one week suggested that the toxic agent or some derivative of it was absorbed by the roots and was being circulated gradually through the plants. When young maize plants growing in soil that had been treated with 2 gm. parathion per pot before planting were infested with eggs, the resulting larvae fed little and many of them died on the leaves, whereas many of those on control plants fed normally and none died on the leaves, though most left because of overcrowding. The compound caused no observable injury to the maize plants in any of the tests and indeed appeared to be somewhat beneficial to them.

KNOWLTON (G. F.). **Boxelder Bug Nymphs feeding on dead Honeybees.**—*J. econ. Ent.* **40** no. 6 p. 915. Menasha, Wis., 1947.

The author reports that he observed adults and nymphs of *Leptocoris trivittatus*, Say, feeding on worker honey bees that were moribund or recently dead in two localities in Utah in May 1947 [*cf. R.A.E.*, A **33** 106]. There was no indication that the bugs would attack or kill active individuals, but their feeding on very much weakened or dead bees and on similar individuals of their own species appears to be not uncommon.

CREIGHTON (J. T.) & GRESHAM jr. (W. B.). **Parathion for Control of Green Peach Aphid on shade-grown Tobacco.**—*J. econ. Ent.* **40** no. 6 pp. 915–917. Menasha, Wis., 1947.

Myzus persicae, Sulz., appeared on shade-grown tobacco in northern Florida and southern Georgia in 1946 and reached outbreak numbers and affected the greater part of the crop in 1947, and it seems likely that it may curtail or stop the cultivation of tobacco there unless satisfactory control measures are discovered. The standard recommendation for the control of this Aphid is to spray or dust with nicotine sulphate, but in tests begun in Florida in the early spring of 1947, 3 per cent. nicotine dust was quite ineffective. The most promising material tested was parathion. This is a deep brown liquid very slightly soluble in water, petroleum ether, kerosene and refined spray oils, but completely miscible in most organic solvents, including alcohols, acetone and cyclohexanone, esters (such as acetates, phthalates, abietates, and animal and vegetable oils), ethylene glycols, ethylether and polymethylated naphthalenes. It may be made up as emulsions, dusts or wettable powders, but should not be used with strongly alkaline materials. In laboratory tests it has been found effective against a wide range of insects, including cockroaches, house-flies [*Musca domestica*, L.], thrips, Coccids, plant bugs, armyworms and the Mexican bean beetle [*Epilachna varivestis*, Muls.]. It seems to have a safe range on a number of plants, especially when used as a wettable powder or dust, but should be applied with normal precautions as it is toxic to warm-blooded animals.

In preliminary tests, 1 per cent. dusts, applied with a hand duster and distributed uniformly on the foliage, caused 90–95 per cent. of the Aphids to drop from the plants within 60–90 minutes and killed all in 12 hours without damaging the plants. Hexaethyl tetraphosphate, applied as a spray, showed similar toxicity, but caused severe scorching of the foliage. *M. persicae* infests the lower surface of the leaves, and in one test in which the parathion dust was applied to the upper surface only, mortality approached 100 per cent.

In field tests, 1 per cent. parathion dust gave complete mortality of the Aphid in 24 hours when applied thoroughly and practically complete mortality when coverage was imperfect, and a 0·5 per cent. dust gave almost complete control when applied thoroughly, but inadequate control when coverage was poor. It is concluded that parathion is a potentially effective compound for the control of *M. persicae*.

Doucette (C. F.). **Stem Borer attacking Lilies.**—*J. econ. Ent.* **40** no. 6 p. 918, 1 fig., 1 ref. Menasha, Wis., 1947.

Larvae identified as *Emboloecia sauzalitae papaipemoides*, B. & B., have been found boring in the stems of lilies in the States of Oregon, California and Washington since 1942. Infestation by this Noctuid has not been extensive enough to be economically serious, but its occurrence in localities extending from San Francisco to the Puget Sound area indicates a possible preference for this food-plant and the borer may increase to serious numbers in the future.

Nickels (C. B.) & Pierce (W. C.). **Effect of Flooding on Larvae of the Pecan Weevil in the Ground.**—*J. econ. Ent.* **40** no. 6 p. 921. Menasha, Wis., 1947.

In tests on the control of *Curculio caryae*, Horn, by flooding, carried out in Texas in 1943, 91 larvae removed from soil in a pecan orchard on 9th July and put in soil covered with water in a jar were dead on 17th July. When the soil under a pecan tree (625 sq. ft.) was flooded from 2nd to 12th August, water 1–4 ins. deep covering the higher portion of the plot for nine days and the lower portion for ten days, 35 per cent. of 112 larvae removed from the flooded soil on 16th August were dead. Air temperatures of 100°F. or higher occurred on all the days during which the soil was flooded, and the soil temperature 4–6 ins. below the surface was 84° on 12th August. When the same area was flooded again from 17th to 27th August, 43 per cent. of 81 larvae removed on 31st August and 3rd September were dead, whereas only 4 per cent. of 53 taken from unflooded soil were dead. It appears that only about one-third of the larvae in the ground can be killed by flooding for ten days, and this reduction is considered hardly enough to be of practical value.

Hutchinson (R. N.). **Influence of Winter Night Temperatures on the California Red Scale.**—*J. econ. Ent.* **40** no. 6 pp. 921–922, 1 fig., 2 refs. Menasha, Wis., 1947.

In the Covina Valley, California, it has been apparent for many years that *Aonidiella aurantii*, Mask., developed slowly in winter, on both lemons and oranges, in areas of low winter temperature, so that numbers were relatively small in spring, whereas populations continued to increase perceptibly during the winter in areas of relatively high winter temperature, resulting in large populations in the spring. To study the relation of temperature to population, the author summarised the orchard infestation records for the area for the summers of 1940–42. The valley was divided into 50-foot contours, and the population density data relating to each area were averaged to give a single figure indicating the relative population density in the orchards situated at that height. Weather records showed that the lowest temperatures occurred at the lowest elevations and that with increasing elevation there was a gradual rise in the average minimum temperature, whereas maximum daytime temperatures varied but little over the valley. A graph on which the average number of nights with temperatures as low as 32 and 28°F. at the different elevations during the period from 15th November to 1st March in 1939–40, 1940–41 and 1941–42 and the relative red-scale population densities at the different elevations during the following summers are plotted shows that populations are bigger at the higher elevations [*cf. R.A.E.*, A **21** 606], and that in general the population density of *A. aurantii* in the Covina Valley is inversely correlated with the number of nights during which the temperature drops to 32°F. or lower during the winter. It is possible that within a given thermal belt, the density of the population in the following summer might be forecast from the number of cold nights during the winter.

RAINWATER (C. F.). **Some Insecticides causing Boll Weevil Mortality inside of punctured Cotton Squares.**—*J. econ. Ent.* **40** no. 6 pp. 923–925. Menasha, Wis., 1947.

In the course of field experiments in which several insecticides were applied as dusts against *Anthonomus grandis*, Boh., on cotton during the summer of 1947, infestation was kept at a low level in some of the plots in a way that suggested a possible ovicidal or larvicidal action of some of the insecticides, and 200 fallen squares in which eggs had been deposited were therefore collected on 22nd July, shortly after the fifth application, from six plots that had received different treatments and kept in the cages until emergence of adults was apparently complete. Emergence began on 31st July, and the numbers of weevils emerging after the different treatments were 102 for calcium arsenate, 12 for BHC (benzene hexachloride) diluted to 6 per cent. γ isomer, 42 for a mixture containing 3 per cent. γ BHC and 5 per cent. DDT, 83 for 20 per cent. chlorinated camphene [toxaphene], 0 for 20 per cent. chlordane, and 117 for 2 per cent. O,O-diethyl O-paranitrophenyl thiophosphate [parathion]. Examination of the squares treated with chlordane showed that development within them was apparently normal to the adult stage, but that the adults were either dead or paralysed. Squares treated with the other insecticides were not examined. During the remainder of the season, eight other series of punctured squares were collected at different times from plots treated with the same insecticides at various strengths, and records were kept of emerging adults, living and dead adults in squares, dead larvae and pupae in squares and dead adults in the cages. The dead larvae and pupae were ignored, however, in estimating the effects of the treatment, as they were not numerous and might have died from natural causes. In general, the results indicated comparatively little mortality of *A. grandis* within punctured squares when calcium arsenate, 50 per cent. DDT in alternate applications, or 1–5 per cent. parathion was applied to cotton in the field. Average mortality was 36 per cent. in the plot treated with 20 per cent. toxaphene, but only 16 per cent. in that treated with 10 per cent. toxaphene. The samples of BHC used, alone and with DDT, were from different sources and had different properties and caused widely different mortalities ; these ranged from 76 to 24 per cent. and did not vary regularly with the γ isomer content of the dusts. Chlordane was the most effective compound tested against *A. grandis* within the bolls, and dusts containing 10 and 20 per cent. caused 84 and 92 per cent. mortality, and those containing 5 per cent. with 5 per cent. DDT or toxaphene 82 and 75 per cent.

BORDEN (A. D.). **DDT Dust Deposits on Pears.**—*J. econ. Ent.* **40** no. 6 pp. 926–927. Menasha, Wis., 1947.

The use of DDT in dusts and concentrated sprays offers a most promising means of controlling the codling moth [*Cydia pomonella*, L.] on apples and pears, providing the correct formulations and dosages of insecticide are used. Investigations were therefore carried out in California to determine whether dust deposition and retention on the fruit could be improved by the addition of an adhesive. Plots of pear trees that had received a delayed calyx spray of 2 lb. 50 per cent. wettable DDT per 100 U.S. gals. on 4th April were dusted twice at 50 lb. per acre or once at 75 lb. and once at 100 lb. per acre with 10 per cent. technical DDT in pyrophyllite, alone and with the addition of 4 per cent. fatty acid derivative, 4 per cent. Vacatone [a dried distiller's molasses residuum product] or 2 per cent. light-medium spray oil as adhesives. Applications were made at night on 22nd April and 8th May, and the fruit was sampled before and after each application and at harvest (1st July). Analysis of the residue

showed that though the initial deposits were higher on fruit treated with dusts containing 2 per cent. oil or no adhesive, the retention of deposit was definitely better when Vacatone or the fatty acid derivative was used. No significant advantage was apparent when the higher dosages of dust were applied. The increase of deposit caused by the second application was much lower than would be expected, but it has been shown in tests with arsenicals on pears that late applications cause only small increases in deposit. Random sampling of fruit from all the plots at harvest showed only two larval entries in 4,000 pears.

KULASH (W. M.). **Benzene Hexachloride, DDT, and Ryanex to control Soybean Caterpillars.**—*J. econ. Ent.* **40** no. 6 pp. 927–928, 1 ref. Menasha, Wis., 1947.

Caterpillars have caused the complete failure of many soy-bean crops in eastern North Carolina for several years: the damage is most severe in Hyde County, where it reaches a peak in the first half of September. The timely use at this time of an insecticide that is quick in action can save a field, and usually only one application is required. The principal species concerned in September 1946 were *Heliothis armigera*, Hb., which injures the pods, and *Anticarsia gemmatalis*, Hb., which feeds on the leaves; when both attack a field of soy beans, immediate action is necessary if the crop is to be saved. Other species common on soy beans at this time were *Prodenia ornithogalli*, Gn., *Laphygma frugiperda*, S. & A., and members of the *Autographa* group.

In field tests, dusts were applied once, at the rate of 25 lb. per acre, on 12th September. They comprised ground and micronised dusts containing 5 per cent. DDT, BHC (benzene-hexachloride) dusts containing 1, 2, 5 and 10 per cent. γ isomer and a 50 per cent. Ryanex dust [*cf. R.A.E.*, A **34** 137], and all resulted in significantly higher yields than no treatment, with no significant difference between them. However, plots treated with 5 and 10 per cent. γ BHC had fewer larvae and higher yields, and those treated with Ryanex had more larvae and lower yields than any other treated plots. In another test, in which two plots were dusted with 5 per cent. DDT, one on 9th and the other on 12th September, the yield from the latter was 34 per cent. less than that from the former.

RONEY (J. N.). **The Beet Armyworm on Flax.**—*J. econ. Ent.* **40** no. 6 pp. 931–932. Menasha, Wis., 1947.

In Arizona, *Laphygma exigua*, Hb., is often present on cotton and lucerne, but is rarely injurious because the first generation is usually practically destroyed by parasites or predators. In 1946, a heavy outbreak occurred on cotton seedlings in Pinal County, but it was controlled with one application of a 5 per cent. DDT dust at 20 lb. per acre. In February 1947, larvae of *L. exigua* were numerous on flowering flax in Yuma County and were feeding on the upper portions of the plants and destroying the fruiting parts, and the same DDT dust was therefore applied at 20 lb. per acre when weather conditions allowed. As the flax was so far advanced, dusting from an aeroplane was the only practical method of application, and one treatment gave complete control of the insects and saved the crop. *L. exigua* was also present on flax in the Imperial valley of California and was controlled in the same manner.

FLEMING (W. E.). **Chlordane for Control of Japanese Beetle Larvae in Turf.**—*J. econ. Ent.* **40** no. 6 pp. 932–933. Menasha, Wis., 1947.

In investigations on soil fumigants, preliminary tests by A. C. Mason & R. D. Chisolm in the spring of 1946 indicated that an emulsion of chlordane

and ethylene dichloride was very effective in killing larvae of *Popillia japonica*, Newm., but slower than an emulsion of ethylene dibromide and ethylene dichloride. Experiments to determine the value of chlordane alone for the control of the larvae in turf were begun by the author in January 1947, and a preliminary report of his results is given in this paper.

In laboratory tests, 1 per cent. dusts of technical chlordane were intimately mixed with sassafras sandy loam at rates equivalent to 0·25, 0·5, 1, 2, 5, 10, 25, 50, 100 and 200 lb. chlordane per acre and 10 per cent. DDT dust was mixed with the soil at 10, 25 and 50 lb. DDT per acre. Larvae in the third instar were introduced into each sample of treated soil immediately after treatment and four and eight weeks later, and mortality was determined at weekly intervals. When freshly applied, 1 lb. chlordane per acre appeared to be as effective as 25 lb. DDT. Chlordane appeared to be as effective as when freshly applied after four weeks, but slightly less effective after eight weeks, when 2 lb. chlordane were required to give results equal to those obtained with 25 lb. DDT.

In May, 5 per cent. dusts of technical chlordane were applied to the surface of four plots of turf in New Jersey and Connecticut at the rate of 10 lb. chlordane per acre, and 10 per cent. DDT was applied to similar plots at the rate of 25 lb. DDT per acre. Larval surveys to a depth of 4 ins. made 4 and 17 weeks later showed apparent average reductions in larval populations of 95·2 and 99·9 per cent., respectively, for chlordane and 60·4 and 88·4 per cent. for DDT. The chlordane reduced the population more rapidly than the DDT and remained sufficiently effective in the soil to eliminate the subsequent brood almost completely by the middle of September. In one pair of plots, the turf was composed of deep-rooted grasses with a dense mat at the surface and the larvae were found as much as 3 ins. below this, whereas in the others relatively shallow-rooted grasses predominated and practically all the larvae were within an inch of the surface. It was evident that under the former conditions, chlordane penetrated sufficiently well into the soil to kill a high proportion of the larvae and DDT did not, indicating that chlordane may be expected to give effective control quickly under a wider range of conditions than DDT.

In view of the favourable results obtained with chlordane in the spring, applications were made in two districts in Massachusetts in late September, while the larvae were still near the surface. Dusting with 5 per cent. chlordane at the rate of 10 lb. chlordane per acre and spraying with 20 lb. 50 per cent. wettable chlordane in 1,200 U.S. gals. water per acre reduced the larval populations by 93 per cent. in 17–18 days. There was no indication that the chlordane had any adverse effect on the various grasses and clover in any of the localities, and in laboratory tests in which established turf of various grasses and clover was sprayed with 50 lb. 50 per cent. wettable chlordane in 1,000 U.S. gals. water per acre (2·5 times the rate used for the control of larvae) and the grass was cut and weighed at intervals after treatment, the chlordane had no effect on colour, general appearance or growth.

Brannon (L. W.). **Piperonyl Cyclonene and Piperonyl Butoxide as Synergists with Rotenone.**—*J. econ. Ent.* **40** no. 6 pp. 933–934, 2 refs. Menasha, Wis., 1947.

In 1947, two experiments were carried out at Norfolk, Virginia, to determine the effectiveness of dilute rotenone dusts to which either piperonyl cyclonene (formerly designated piperonyl cyclohexenone [*cf. R.A.E.*, B **37** 116]) or piperonyl butoxide [*cf.* A **37** 299] was added as a synergist, against *Epilachna varivestis*, Muls., on beans. The insecticides were applied with hand dusters to both sides of the row so that the under surface of the leaves was covered. Commercial materials used in preparing the dust mixtures were cubé-root

powder (3·6 per cent. rotenone, 13·5 per cent. total extractives), 2·5 per cent. piperonyl cyclonene on walnut-shell flour, 5 per cent. crude piperonyl butoxide on walnut-shell flour and 51·5 per cent. DDT. Pyrophyllite, with the addition of sulphur where stated, was used as the diluent.

In the first experiment, the dusts were applied on 4th, 12th and 25th June, and counts showed that a dust containing 0·22 per cent. rotenone with 0·5 per cent. of either of the piperonyl compounds was as effective (92–96 per cent. control) against the larvae of *E. varivestis* as one containing 0·45 per cent. rotenone, 3 per cent. DDT and 50 per cent. sulphur, though the latter was the more effective against the adults. In the second experiment, dusts were applied on 15th, 21st and 28th July and 5th August and, under conditions of unusually heavy infestation and extremely adverse weather, a dust containing 0·125 per cent. rotenone, 0·5 per cent. piperonyl cyclonene and 25 per cent. sulphur controlled the larvae to about the same extent (98 per cent.) as the recommended dust of 0·5 per cent. rotenone, 3 per cent. DDT and 50 per cent. sulphur, with increases of 64 and 65 bushels of marketable beans per acre, respectively, over untreated plots. When piperonyl butoxide was substituted for piperonyl cyclonene, a greater number of larvae survived and the increase in yield was only 41 bushels per acre. A mixture containing 0·125 per cent. rotenone alone in sulphur and pyrophyllite was ineffective.

In limited tests with the piperonyl materials in the absence of other insecticides, 0·5 per cent. dusts had no significant effect on larvae and pupae of *E. varivestis*, although in 1946, 0·5 per cent. piperonyl cyclonene had given 77 per cent. control of the larvae and pupae in one experiment and 52 per cent. in another. This difference in effectiveness may have been due to the dusts employed. In 1946, the dust was prepared by spraying a solution of piperonyl cyclonene in an equal volume of acetone on pyrophyllite, whereas in 1947 commercial preparations of piperonyl cyclonene and piperonyl butoxide on walnut-shell flour were diluted with pyrophyllite.

It is concluded from these preliminary experiments that both piperonyl cyclonene and piperonyl butoxide have a synergistic effect when used in dilute rotenone dusts against *E. varivestis*.

YOTHERS (M. A.). **DDT and the Woolly Apple Aphid Parasite** *Aphelinus mali*.—*J. econ. Ent.* **40** no. 6 p. 934, 2 refs. Menasha, Wis., 1947.

Where DDT insecticides have been used on apple in the north-western United States, they have so affected the activity of *Aphelinus mali*, Hald., that it is no longer able to control *Eriosoma lanigerum*, Hsm., and the Aphid threatens to become a destructive pest that will require the application of sprays for its control [*cf. R.A.E.*, A **36** 98]. In this region it is intimately associated with perennial canker of apple, caused by *Gloeosporium perennans* [*cf.* **17** 666, etc.].

PRILL (E. A.), HARTZELL (A.) & ARTHUR (J. M.). **Insecticidal Thio Ethers derived from Safrole, Isosafrole, and other Aryl Olefins.**—*Contr. Boyce Thompson Inst.* **14** no. 3 pp. 127–150, 19 refs. Menasha, Wis., 1946.

A number of insecticidal compounds discovered in the past few years, including that known as piperonyl cyclohexenone [or piperonyl cyclonene (*R.A.E.*, A **37** 305)], contain the 3,4-methylenedioxyphenyl radical in their molecules [*cf.* B **34** 61; **35** 186]. Safrole, a major component in certain

essential oils, is probably the most important primary natural raw material for preparing intermediates for the synthesis of more complex compounds containing this radical. It is easily isomerised into isosafrole, and this oxidised to piperonal or piperonylic acid. Both safrole and isosafrole were found to react very readily with any of a number of sulphydryl compounds. Most of the products so formed proved active as insecticides against house-flies [*Musca domestica*, L.] [*cf.* B **37** 159], and both these and products made with certain other aryl olefinic compounds instead of safrole or isosafrole, most of which were relatively inactive against house-flies, were effective against certain agricultural pests.

Although many compounds containing a 3,4-methylenedioxyphenyl radical are active insecticides or synergists with pyrethrum, it would be unwarranted to assume that its presence would impart insecticidal activity to any organic molecule. Many types of compounds containing it were prepared and tested, and although some were effective, many others were relatively inactive against house-flies. It appears that a methylenedioxy substituent on a benzene ring may contribute activity to a compound only if the compound also contains one or more other structural components of suitable types. Moreover, the introduction of still another structural component into an active compound of this type may either increase or reduce activity.

In laboratory tests in which emulsions formed by mixing a weighed amount of the test compound, usually 0·1 gm. in 10 ml. acetone, with 90 ml. of a 0·1 per cent. aqueous solution of sodium lauryl sulphate were atomised on to infested leaves and the latter were placed in petri dishes and covered after the acetone had evaporated, examination after 20 hours showed that the products of safrole and isosafrole with n-hexyl mercaptan or with 2-(2-n-butoxyethoxy) ethyl mercaptan or of safrole with 2-(2-phenoxyethoxy)ethyl mercaptan gave 99–100 per cent. kill of *Aphis fabae*, Scop. (*rumicis*, auct.) on bush bean, and several other similar products gave 64–96 per cent. kill, whereas the products of safrole and isosafrole with benzyl mercaptan, which gave complete kill of all active stages of *Tetranychus telarius*, L., on bush bean when applied at 0·25 per cent., gave only 3 and 9 per cent. kill of the Aphid. The products of safrole with butoxyethoxyethyl mercaptan and of isosafrole with 2-benzoxyethyl mercaptan gave 99 and 100 per cent. kill of *Macrosiphum onobrychis*, Boy. (*pisi*, Kalt.) on broad bean [*Vicia faba*], and the four other products tested gave at least 78 per cent. kill. The products of safrole and isosafrole with butoxyethoxyethyl mercaptan and benzoxyethyl mercaptan gave 100 per cent. kill and those of safrole and isosafrole with phenoxyethoxyethyl mercaptan gave 93 and 94 per cent. kill of adults and nymphs of *Thrips* sp. on chicory. The N-cyclohexylamide and piperidide of the acid produced by the reaction of safrole and mercaptoacetic acid both gave 99 per cent. mortality of *A. fabae*, the former gave 100 per cent. kill of *Thrips* and *M. onobrychis*, and the latter 49 per cent. kill of *Tetranychus*. The products of styrene and isosafrole with di-n-butyl disulphide (catalysed by iodine) gave 83 and 42 per cent. kill of *A. fabae*, respectively. The products of the peroxide-catalysed addition reaction of styrene and benzyl mercaptan and of 2-vinylpyridine and n-butyl mercaptan gave complete kill of *A. fabae*, and four similar compounds gave more than 80 per cent. kill. The first of these six also gave complete kill of *Tetranychus* (when a 0·25 per cent. emulsion of the chemical was used) and of *Thrips*, and the second gave complete kill of *Tetranychus* in a 0·25 per cent. emulsion. Mortality among untreated controls was never more than 8 per cent.

Unlike those on house-flies, these tests suggest that the methylenedioxy substituent on a benzene ring may not be necessary in the structures of these thioethers to make them insecticidal. It is possible, however, that the thioethers containing a methylenedioxy substituent may be effective as synergists with pyrethrum against other insects as well as house-flies, as piperine has been shown to be. When 0·2 per cent. emulsions of the products of safrole and

isosafrole with hexyl mercaptan, of safrole with benzyl mercaptan or 2-phenoxyethyl mercaptan, or of isosafrole with butoxyethoxyethyl mercaptan, phenoxyethyl mercaptan or benzoxyethyl mercaptan or similar emulsions of the N,N-di-n-butylamides of the acids formed from safrole or isosafrole and mercaptoacetic acid were similarly tested against larvae of *Epilachna varivestis*, Muls., on bush bean leaves, practically no feeding occurred during the test period of 48 hours; untreated larvae continued to feed.

In greenhouse tests on *Digitalis* plants, which are generally very susceptible to injury by chemicals, an emulsion containing 0·2 per cent. of the product of isosafrole and benzoxyethyl mercaptan caused no injury during a month, whereas one containing 0·4 per cent. of this compound caused moderate leaf injury. The product of isosafrole and butoxyethoxyethyl mercaptan caused no injury during two weeks at 0·1 per cent., but moderate leaf injury at 0·2 per cent., and the products of safrole with hexyl mercaptan, butoxyethoxyethyl mercaptan or phenoxyethoxyethyl mercaptan and the N,N-di-n-propylamide of the acid produced from safrole and mercaptoacetic acid caused some leaf injury within a week at 0·2 per cent. At 0·1 per cent., the products of safrole and isosafrole with butoxyethoxyethyl mercaptan caused no apparent injury to bush beans during two weeks. The effects on plants of the other compounds dealt with in this paper were not determined.

In acute toxicity tests, white rats that were fed for one week exclusively on a diet containing 0·2 per cent. of the products of isosafrole and butoxyethoxyethyl mercaptan or benzoxyethyl mercaptan or of the N-cyclohexylamide of the acid produced from safrole and mercaptoacetic acid, which were among the most effective against house-flies, showed no harmful effects during this period or the following month, and it is concluded that these and closely related compounds are probably not seriously toxic to warm-blooded animals.

Stewart (W. D.) & Standen (J. H.). **Polymeric organic Polysulphides as Fungicides and Spray Adjuvants.**—*Contr. Boyce Thompson Inst.* **14** no. 3 pp. 203–220, 3 figs., 14 refs. Menasha, Wis., 1946.

Of the polymeric organic polysulphides that have been developed in the United States as stable latices of fine particle size for use as fungicides and spray adhesives, the most suitable for commercial use is polyethylene pentasulphide, which is prepared by condensing ethylene dichloride and sodium pentasulphide and was the material used in the tests reported by Hopperstead [*R.A.E.*, A **37** 183]. Its properties are described [*cf. loc. cit.*]. In addition to numerous experiments showing its value as a fungicide, two are recorded in which it was used as an adhesive in insecticidal sprays in New York. Apple trees heavily infested with *Aphis pomi*, Deg., were sprayed with 0·75 pint nicotine sulphate per 100 gals., alone and with 0·5 per cent. polyethylene pentasulphide, on 30th March, 1945, when the temperature was 65–70°F., and counts of Aphids on sample buds after 48 hours showed kills of 60·5 and 99·2 per cent., respectively. In tests against *Cydia* (*Carpocapsa*) *pomonella*, L., on apple, the addition of 0·25 per cent. polyethylene pentasulphide to sprays of 4 lb. lead arsenate per 100 U.S. gals., up to and including the fourth cover spray, caused severe splitting, russetting and stunting of the fruits and injury to foliage owing to the excessive spray deposit that occurred in spite of heavy rainfall; no fruits were damaged by larvae. The fruit and foliage of trees sprayed with 2 lb. lead arsenate per 100 U.S. gals. with 0·25 per cent. polyethylene pentasulphide five times against the first generation and twice against the second appeared normal throughout the season. Less than 4 per cent. of the fruits were infested, as compared with 8–10 per cent. in a neighbouring orchard sprayed with 3 lb. lead arsenate per 100 U.S. gals. and 32 per cent. on unsprayed trees.

Smith (F. F.), Fulton (R. A.) & Brierley (P.). **Use of DDT and H.E.T.P. as Aerosols in Greenhouses.**—*Agric. Chem.* **2** no. 12 pp. 28–31, 61 ; **3** no. 1 pp. 37, 39, 77, 3 figs., 6 refs. Baltimore, Md., 1947–48.

The following is based on the authors' summary. Recent experiments in commercial greenhouses in the United States have shown that the use of DDT and HETP (hexaethyl tetraphosphate) in liquefied-gas aerosols provides a rapid and efficient method of controlling greenhouse insects. DDT aerosols, which leave a toxic residue, were found to be effective against a variety of insects but did not give good control of Aphids, while HETP, which acted as a fumigant when applied as an aerosol, was effective against the two-spotted spider mite [*Tetranychus bimaculatus*, Harvey], the greenhouse whitefly [*Trialeurodes vaporariorum*, Westw.], the Mexican mealybug [*Phenacoccus gossypii*, Tns. & Ckll.], the citrus mealybug [*Pseudococcus citri*, Risso] and ten species of Aphids, but not against the broad mite [*Hemitarsonemus latus*, Banks] or two species of snails, the only other pests against which it was tested. The aerosols were applied, usually at dusk, by means of a knapsack dispenser, and the operator wore a mask. A solenoid dispenser with a valve operated by electricity with the switch outside the greenhouse appeared to be suitable for small greenhouses.

For the DDT aerosols, which contained technical DDT with Velsicol AR–60 and Freon-12 (dichlordifluoromethane) (5 : 10 : 85), Velsicol AR–60, acetone and Freon-12 (5 : 5 : 10 : 80) or cyclohexanone, Velsicol AR–60, acetone and Freon-12 (5 : 5 : 5 : 3 : 82), 100 gm. aerosol solution per 1,000 sq. ft. floor space appeared to be an adequate dosage. No injury to foliage or flowers of greenhouse plants occurred, except on cucumber when aerosols containing cyclohexanone were used. There was no ill effect on honey bees or on their pollination of cucumbers when the aerosols were applied at dusk after the hive entrances had been covered.

The HETP aerosol, which consisted of 10 per cent. HETP in methyl chloride, was toxic when applied at the rate of 10 gm. solution per 1,000 cu. ft., and dosages as low as 3 gm. per 1,000 cu. ft. were effective against Aphids and whiteflies. Eggs and other quiescent stages of *Tetranychus*, eggs of mealybugs and immature stages of whiteflies were not killed by one application, but repeated applications at intervals of three days resulted in complete control of mites on certain crops, and applications at weekly intervals eliminated whiteflies. Plant injury occurred on tomato and chrysanthemum, and certain varieties of these appeared to be more susceptible than others. Over 130 other plant species, including most of the commercial greenhouse crops, were unaffected by repeated applications. The injury on susceptible plants seemed to be more severe when they were treated at low temperatures, and was almost entirely avoided by treating them at temperatures above 70°F. Aerosols containing HETP and methylene chloride with Freon-12 (10 : 20 : 70) or propane (20 : 40 : 40) were also tested to a limited extent, but were less effective than the methyl-chloride aerosol against Aphids and mites when applied at the same concentrations.

Treatment with aerosols requires considerably less time and labour than spraying or dusting, and their use reduces the danger of disease spread following the application of water sprays. Methods are described for preparing and applying the aerosols, and it is emphasised that when HETP aerosols are being prepared, it is essential to handle the materials under anhydrous conditions.

Peterson (P. D.). **Field Experiments with DDT and BHC Sprays on Apple and Peach in 1946.**—*Trans. Peninsula hort. Soc.* 1946 pp. 82–84. Dover, Del. [1947.]

Field tests were made with sprays of DDT and BHC (benzene hexachloride) in the Appalachian and Eastern Shore areas of Maryland and neighbouring

States in 1946, in which DDT was used primarily on apple against the codling moth [*Cydia pomonella*, L.] and BHC primarily on peach against the curculio [*Conotrachelus nenuphar*, Hbst.]. In most orchards, DDT was more effective than combinations of lead arsenate, oil and nicotine in controlling *Cydia pomonella*, which was practically eradicated from one orchard in Maryland by four applications against the first generation ; the final appearance of the fruit was superior to that obtained in previous years. Comparable results were obtained in other orchards in which the sprays were applied promptly and thoroughly. The trees also remained free from leafhoppers throughout the season.

The European red mite [*Paratetranychus pilosus*, C. & F.] increased to injurious numbers prior to harvest in most of the DDT-sprayed apple orchards, appearing first in those in which the dormant or delayed dormant applications of oil had been omitted. In general, delayed dormant sprays were more effective against it than dormant sprays, and a thorough delayed dormant application occasionally gave practical control throughout the season. Oil at a concentration of 6 quarts per gal. was consistently effective as a summer treatment against the mites, but repeated applications impaired the size and colour of the fruit. DN-111 [containing a dicyclohexylamine salt of dinitro-ortho-cyclohexylphenol] was more effective against them when used alone than in combination with DDT. It was usually ineffective when applied after Bordeaux mixture and certain other sprays containing lime, and it severely scorched the foliage in some orchards at temperatures above 90°F. When applied alone at moderate temperatures, it was not injurious, gave high initial mortality and, in the absence of rain, continued to kill newly-hatched mites for several days. Xanthone prevented any appreciable increase in mite populations, but was ineffective in controlling heavy infestations. Hexaethyl tetraphosphate, used in limited field tests, gave high initial mortality of mites but did not leave a toxic residue ; its effectiveness is lost in the presence of lime. In most apple orchards in which DDT was used instead of lead arsenate after the first cover spray, the red-banded leaf-roller [*Eulia velutinana*, Wlk.] became injurious [*cf. R.A.E.*, A **36** 323] and, especially where there were adjacent peach orchards, *C. nenuphar* caused very severe damage late in the season. The woolly aphis [*Eriosoma lanigerum*, Hsm.] was usually more numerous where DDT was used, but nevertheless caused little damage.

Lead arsenate injures the twigs, foliage and fruit of peach trees to which it is applied for the control of *C. nenuphar*. No such damage was caused by BHC which, applied four times at intervals of 7–10 days beginning with the shuck-split spray, gave consistently superior control during the period of application, but was less effective than lead arsenate in preventing damage by weevils that emerged later. Effective control by BHC is likely to involve spraying until emergence has ceased, with a total of five applications or more, and the cost would be high.

MacCreary (D.) & Detjen (L. R.). **A southern Insect of Interest to Delaware Tomato Growers.**—*Trans. Peninsula hort. Soc.* 1946 pp. 94–95, 1 fig., 1 ref. Dover, Del. [1947.]

In the course of experiments in Delaware in 1946, some tomato plants became abnormally brittle and broke readily when handled. Considerable numbers of *Engytatus geniculatus*, Reut. (*Cyrtopeltis varians*, Dist.) were present on the plants, and their feeding on the stems was found to be responsible for the abnormality. The damage first appeared as a fine, dark line encircling the stem, which later became swollen at this point. Treatment with a dust containing 5 per cent. DDT gave good control. This Mirid appears to be widely distributed in the southern United States and Hawaii and has been

observed damaging greenhouse tomatos in Maryland; it is not known how it entered Delaware, but it is unlikely to be able to overwinter there.

Rockwood (L. P.). Zimmerman (S. K.) & Chamberlin (T. R.). **The Wheat Stem Maggots of the Genus *Meromyza* in the Pacific Northwest.**—*Tech. Bull. U.S. Dep. Agric.* no. 928, 18 pp., 1 fig., 21 refs. Washington, D.C., 1947.

This bulletin was compiled from information collected in Oregon over a period of 20 years, and the following is mainly from the authors' summary. Two species of *Meromyza*, *M. pratorum*, Mg., and *M. saltatrix*, L., occur in the Pacific Northwest of the United States. Each has seasonal colour forms. It is probable that both are generally distributed over the area, but *M. saltatrix* seems to be limited to localities that have an average annual precipitation of 15 ins. or more. The food-plants of both are graminaceous plants in general, but, in the Pacific Northwest, *M. saltatrix* damages spring-sown wheat in April and May more commonly than does *M. pratorum*, which infests grasses more often than grains, in May and June. Serious outbreaks of *M. saltatrix* have occasionally occurred on wheat there and in Europe and Asia. Three types of injury to wheat by these Chloropids have been recorded, of which the first two are common [*cf. R.A.E.*, A **26** 122]. When young tillers of spring-sown wheat are attacked in May before the culm is well formed, the feeding of the larva within the tiller cuts off the central shoot, which withers and dies. When headed culms are attacked, the entire head is killed and remains empty of kernels. Injury of these two common types occurs also on barley, rye and the grasses. That of the third type, seldom observed in Oregon, is caused by larvae of *M. saltatrix* feeding on wheat heads that have begun to form seed [*cf.* **20** 238], in which case the affected parts of the heads may be completely destroyed.

Both *M. pratorum* and *M. saltatrix* overwinter in the larval stage in the stems of their food-plants. The adults emerge in April or May, adults of *M. pratorum* about three weeks later than those of *M. saltatrix*. The fact that both species select the youngest plants available accounts for the greater damage to spring-sown wheat by *M. saltatrix*. *M. saltatrix* has only one complete generation a year, whereas *M. pratorum* has two. The average developmental period observed for *M. saltatrix*, from egg to adult, was 76·5 days, from late April until July. The observed mean developmental period for the spring generation of *M. pratorum* was about 85 days, in May, June and July, but that of the summer generation was as short as 30 days, in July and August.

The summer emergence of flies of both species takes place in July. Adults of *M. saltatrix* aestivate for 30 days or more before ovipositing and die early in October. Those of *M. pratorum* oviposit in July and August on whatever food-plants are available, and the autumn emergence occurs in September, but some of the flies are in the fields until mid-October. Since little if any autumn-sown wheat is up until after 15th October in the Pacific Northwest, neither species seriously damages this crop. Self-sown grains and the grasses are usually all the food-plants available at that time, although in some seasons and areas, second-growth of grain cut prematurely for hay is an important overwintering host. The number of available plants for overwintering depends on late-summer precipitation and every recorded outbreak in the Pacific Northwest was preceded by precipitation above normal in August or early September.

Larvae that are well up in the stems in winter are probably killed by severe cold, but those in the crowns of the plants probably survive. Parasites are of negligible importance in control, especially in semi-arid regions, where the most extensive outbreaks have occurred. Those reared by the authors

comprised *Coelinius* (*Coelinidea*) *meromyzae*, Forbes, from overwintering larvae of both species in March and April, *Bracon* (*Microbracon*) *meromyzae*, Gah., from larvae of *M. pratorum* on barley in August, and *Eupteromalus* sp. and *Eupelmus allyni*, French, possibly from the spring generation of *M. saltatrix*, in June. Adults in cages were sometimes killed by the fungus, *Empusa muscae*. The ploughing under of self-sown and second-growth wheat before April, the close pasturing or ploughing under of neighbouring grasses, and the sowing of quickly maturing varieties of spring wheat are recommended in years in which an outbreak threatens.

Hawes (I. L.) & Eisenberg (R.). **Bibliography on Aviation and economic Entomology.**—*Bibliogr. Bull. U.S. Dep. Agric.* no. 8, iv+186 pp. Washington, D.C., 1947.

This bibliography covers 1,084 papers published during 1919–45, inclusive, and includes brief descriptions or abstracts of their contents. They are arranged alphabetically by authors for each year, and the subjects include the use of aircraft for applying insecticides, the question of injury by the latter to plants, bees, livestock and wildlife and to aircrews and ground personnel, the transport of insects in aircraft and the attendant problems of disinfestation and quarantine, aircraft studies of the aerial fauna, and aerial scouting and mapping of infested areas. There is an index to subjects and authors.

Baerg (W. J.). **Introduction to applied Entomology.**—3rd edn. revd., 11×8¼ ins., [1+] vii+191 pp., 208 figs., many refs., multigraph. Minneapolis, Minn., Burgess Publ. Co., 1949. Price $3.50.

This third edition resembles the second [*R.A.E.*, A **31** 269] in general scope and arrangement, but the information on bionomics has been brought up to date where necessary and sections on recently developed insecticides and biological control have been added.

Morgan (C. V. G.). **Influence of Oil on Toxicity of Benzene Hexachloride.**—*Canad. Ent.* **79** no. 6 p. 109. Guelph, Ont., 1947.

In experiments in British Columbia in 1946, a wettable powder containing benzene hexachloride and 50 per cent. sulphite lye (goulac) was used in sprays applied to fruit trees with or without the addition of 0·5 gal. oil per 100 gals. The concentration of γ isomer in the sprays was 0·25 lb. per 100 gals. The insects sprayed were *Myzus cerasi*, F., on cherry, *Hyalopterus arundinis*, F., on plum, *Eriosoma lanigerum*, Hsm., and *Aphis pomi*, Deg., on apple, and *Psylla pyricola*, Först., on pear, and the average mortality percentages were 98·8, 69·5 and 4·8 for sprays with and without oil and no treatment, respectively. The mortalities of the different species given by sprays with oil differed very little from one another, and the increase was especially marked in the tests with the resistant species, *E. lanigerum* and *H. arundinis*. In a further experiment with *H. arundinis*, the mortality percentages were 100 and 99·9, respectively, for 0·5 and 0·25 lb. γ isomer with 0·5 gal. oil per 100 gals., 99·6 for 0·125 lb. with 0·25 gal. oil, 97·2 for 0·0625 lb. with 0·125 gal. oil, 51·4 for 0·25 lb. without oil and 1·3–1·4 for no treatment.

McGuffin (W. C.). **New Descriptions of Larvae of Forest Insects : *Semiothisa*, *Dysmigia* (Lepidoptera, Geometridae).**—*Canad. Ent.* **79** no. 6 pp. 113–116. Guelph, Ont., 1947.

The larvae described in this part of a series on Canadian forest insects [*cf. R.A.E.*, A **35** 268] are those of *Semiothisa sexmaculata*, Pack., which attack larch, and *Dysmigia loricaria*, Evers., which attack poplar and willow.

King (K. M.) & Andison (H.). **A Simple Plough-equipment for applying liquid Fumigants to the Soil.**—*Process. Publ. Div. Ent. Dep. Agric. Can.* no. 68, 6 pp., 3 figs. Ottawa, 1947.

Details are given of an apparatus for applying liquid fumigants to the soil, with brief notes on its use. A shallow petrol tank, with a simple cut-off valve screwed into the bottom, is mounted on a wooden support on a plough drawn by a tractor. Separate tubes fitted with regulating valves lead from the tank to each furrow, and their outlets are so placed in front of the ploughshares that the liquid trickles along the open furrows before it is covered by the next slices of soil.

Gunn (D. L.) and others. **Aircraft Spraying against the Desert Locust** (*Schistocerca gregaria* **Forskål**) **in Kenya, 1945.**—*Anti-Locust Bull.* no. 4, 121 pp., 11 pls., 33 figs., 8 refs. London, 1948.

Work with dusts applied from aircraft against locusts had indicated that they were not altogether satisfactory, and the possibility of using sprays was therefore tested against *Schistocerca gregaria*, Forsk., in Kenya in 1945 following preparatory work in that country and at Porton in England earlier in the year [*R.A.E.*, A **36** 375 ; **37** 19, 119]. This bulletin contains a detailed account of the work, which is described in ten chapters under the headings of Aerial Spraying Methods (pp. 9–16), Terrain and Reconnaissance (pp. 17–30), including a section on aerial reconnaissance by J. F. Graham, Delimiting and Demarcating a settled Swarm for Spraying (pp. 31–36), Aircraft Operation (pp. 37–45) by E. C. Jaques, Air-to-Ground Spraying Trials (pp. 46–51), Spray Assessments (pp. 52–64) by J. Ward, Mortality Assessments (pp. 65–72), Air-to-Air Spraying Trials (pp. 73–80), and The Physics of Spraying (pp. 81–109) by J. Ward. There are also four appendices, of which two, both by E. C. Jaques, deal with the aerial spraying installations in the aircraft and the aerial smoke markers used in the work, and the other two with the preparation of spray mixtures and with radio communications.

The following is largely based on the authors' summary, conclusions and recommendations (pp. 4–8). The spray used in the tests contained about 2½ lb. DNC (dinitro-ortho-cresol) in a mixture of 5 gals. light diesel oil and 5 gals. furnace oil. It was applied by Baltimore aircraft that had been modified for anti-malarial spraying and were fitted with a standard 300-gallon bomb-bay overload fuel tank and a retractile emission pipe with an outlet diameter of 2½ ins. Attempts were made to spray swarms on the ground and in the air. It was necessary to determine the exact location of settled swarms in the evening after they had settled, and the whole spraying operation, including the delimitation of the swarm and the demarcation in it of a target area over which the spray was to be applied, had to be completed within three hours of sunrise the next morning [*cf.* **37** 119]. Reconnaissance was difficult, since the terrain was often bad and the roads poor, and although aircraft were sometimes of assistance, a ground party had always to reach the swarm to mark it out for spraying. Good communications with the aircraft base by wireless telegraphy and with the aircraft by radio telephony were essential. The spraying technique developed at Porton required the aircraft to fly at 200 miles per hour at such a height that the product of height in feet and wind speed in miles per hour was 700 and to make eight runs as nearly as possible across wind at intervals of 50 yards for a target area of 800 × 500 yards with the long side at right angles to the wind. Owing to the breaking up of the oil into drops of various sizes and therefore of various terminal velocities, the wind would spread the spray

over the 50-yard gap, and it was estimated that the dosage per sq. metre would be 2–2·7 cc. over some 300 yards of the target width and 1–2 cc. for another 130 yards, 1 cc. per square metre being about 0·9 gal. per acre. It was thought that the rate of discharge of oil from the Baltimore aircraft, which was fixed, would be 2·4 gals. per second, and the discharge for the whole operation nearly 160 gals.

Five trials were made, and the estimated mortality obtained varied from 40 to 70 per cent., but may have been only half as great. Improved methods of estimating mortality are suggested on the experience gained. Tests of spray deposited made after the trials were over showed that more than half the spray did not reach the ground in the target area, the deposit was too uneven, because the aircraft flew too low for the type of oil used, and about half the DNC had probably separated from the solution because furnace oil was used instead of lubricating oil. Consequently, in the first trial, the dosage per sq. metre was between 0·1 and 1 cc. in nearly 90 per cent. of the 60 acres in which more than traces of the spray fell and exceeded 1 cc. in only about 10 per cent. of the area. As the estimated mortality rate in this area exceeded 70 per cent., the poison may be more effective in the field than in the laboratory. In all the trials, the area dosage probably averaged 2–5 oz. DNC per acre, and this should be considered in relation to the density of basking locusts, which can be equivalent to 1 ton per acre and possibly ten times as much. The locusts were in the vulnerable fledgling stage [a term used for freshly emerged adults that are still grey in colour], but it is thought that, with the errors rectified and a higher concentration of DNC this technique should provide adequate mortality for control under suitable conditions. Apart from this demarcation of the area, its success depends on the skilfulness of the pilots, and correct prediction of wind direction, which is often variable early in the morning. Much of the advantage of speed of aircraft is, however, lost because of their dependence on the much slower ground team, and the possibility of using helicopters for reconnaissance and rapid demarcation is suggested. Older locusts and swarms in the hotter lowlands would take to flight earlier in the morning, leaving still less time for the operation. Locusts densely congregated or among dense vegetation might be shielded from the spray.

Two techniques for attacking flying swarms were developed at Porton, one designed for swarms in which all the locusts were in flight, and the other for rolling swarms, in which a proportion was always on the ground, the remainder passing on over them. The first method consists in placing a curtain of spray droplets at right angles to the advancing front of the swarm by making repeated spraying runs along a line marked by aerial smoke markers so that a continuous sheet of spray is formed down to the ground. This method was not tested adequately, as only rolling swarms were encountered and the aerial markers tended to cause fires on the ground, but it showed promise in partial tests. The other technique was devised hastily to meet the immediate need for a method of dealing with rolling swarms. It differs from the first in that the sheets of spray are laid over stationary markers on the ground, and the locusts pass through successive curtains of spray, each with a sub-lethal dose. Eight trials of the method showed that it has inherent weaknesses and that it is most likely to be of value when the flying locusts are heading within 20° of up or down wind and when the swarm is elongated in the same direction. It is less economical than the first method as it necessitates spraying for a longer period ; this is because a rolling swarm moves slowly over the ground and so takes much longer to pass through the curtain than a flying one. Mortality could be estimated numerically in only one trial, in which about three million locusts were killed, perhaps 1 per cent. of a small swarm. Experimental spraying of moving swarms should be carried out late in the afternoon, so that as much mortality as possible will occur in the roosts, where it can be estimated.

VAN DER PLANK (J. E.). **The Relation between the Size of Plant and the Spread of systemic Diseases. II. The Aphis-borne Potato Virus Diseases.**—*Ann. appl. Biol.* **35** no. 1 pp. 45–52, 18 refs. London, 1948.

The following is based on the author's summary. It is an implication of systemic infection by the Aphid-borne viruses that potato plants with large haulms should be specially vulnerable to infection, and this implication was supported by evidence obtained in South Africa, when it was found that the numbers of *Myzus persicae*, Sulz., per 100 leaves on large, medium and small plants in the same field were about the same, so that the larger plants bore larger total populations and would be more exposed to infection. Haulms are reduced in size by short days, low temperatures, under-nutrition and varietal differences. Certain observations are adduced to show that these factors reduce vulnerability. It is suggested that the transference of the potato from the short days, infertile soils and primitive cultivation on the Andes to the long summer days and productive farming of Europe and North America enhanced its vulnerability to Aphid-borne diseases. The further effects of changes of temperature and manurial practices in the last century need elucidation.

POSNETTE (A. F.) & STRICKLAND (A. H.). **Virus Diseases of Cacao in West Africa. III. Technique of Insect Transmission.**—*Ann. appl. Biol.* **35** no. 1 pp. 53–63, 8 refs. London, 1948.

This third paper of a series [*cf. R.A.E.*, A **37** 232] contains an account of the laboratory technique developed in the Gold Coast for obtaining experimental transmission of cacao virus 1, which causes swollen-shoot disease, by means of mealybugs. The work was done with strain A virus, and the principal results obtained with *Pseudococcus njalensis*, Laing, have already been noticed [**37** 85–86]. *Ferrisia virgata*, Ckll., transmitted the virus in an essentially similar manner. The crawlers appeared to be the most effective vectors in each case. Experiments in which *Toxoptera aurantii*, Boy. (*coffeae*, Nietn.) and *Mesohomotoma tessmanni*, Aulm., failed to transmit the virus [**37** 85] are briefly described.

RAINEY (R. C.). **Observations on the Development of the Cotton Boll, with particular Reference to Changes in Susceptibility to Pests and Diseases.**—*Ann. appl. Biol.* **35** no. 1 pp. 64–83, 4 figs., 46 refs. London, 1948.

The following is almost entirely the author's summary of observations in the Transvaal. Continuous and well-marked changes in composition occur during the development of cotton bolls and are discussed in relation to changes in susceptibility to pests and diseases. Cotton buds and flowers, the main food of the earlier instars of *Heliothis armigera*, Hb., and *Diparopsis castanea*, Hmps., and, at the beginning of the season, of *Platyedra gossypiella*, Saund., represent the richest recorded source of nitrogen available to the larvae. The first two weeks of boll development, when most physiological shedding occurs, are characterised by extremely rapid growth, the dry weight of the ovules being approximately doubled every two days. The developing ovules are richest in reducing sugars during the second and third weeks, when moisture-content is also highest. Bolls of this age are attacked by the later instars of *Heliothis* and *Diparopsis*, which are the stages at which the accumulation of larval fat is likely to be most active. Males of *Dysdercus nigrofasciatus*, Stål, which can survive for prolonged periods on simple sugar solutions, show a marked preference for bolls of this age, which are punctured to a varying extent by other stages of *Dysdercus*, probably primarily as a source of water. This is also the stage at which attack by *Nematospora*, which is transmitted

by *Dysdercus*, is most damaging ; reducing sugars provide a highly suitable source of carbon for the fungus.

The cellulose of the mature lint and the oil and protein of the ripe seed are mainly laid down after the boll has reached full size (at 4–5 weeks under local conditions), about half-way through its maturation period, and are largely derived from materials entering the boll in the course of its subsequent development. Premature senescence, such as that associated with *Alternaria* attack, can thus affect yield even when defoliation does not occur until after most of the bolls have attained full size. The ripening seed, becoming steadily richer in oil and protein during the latter part of boll development, forms the main food of *Platyedra* towards the end of the season, a change of diet reported to induce larval diapause [*R.A.E.*, A **28** 532, etc.]. Ripe seed provides food that is essential for satisfactory nymphal development and probably also for oviposition in *Dysdercus* ; specific protein requirements are possibly involved.

Examples of the direct effects of environmental factors on the development and composition of the boll are described. Over the range of conditions experienced by the experimental material, these effects were relatively small.

Hewlett (P. S.). **Physical Factors affecting the Toxicity of Sprays to Stored Product Insects. I. The Quantity of Carrier in which a given Amount of active Ingredient is applied.**—*Ann. appl. Biol.* **35** no. 1 pp. 84–93, 13 refs. London, 1948.

The following is virtually the author's summary. The problem of whether a given amount of active ingredient is more effectively applied in concentrated or dilute form is discussed. If y is percentage mortality and x_1 and x_2 are respectively log-concentration of active ingredient and log-volume (or deposit) of insecticide applied, y may be regarded as a uniform, continuous function of x_1 and x_2. The amount of active ingredient is constant, *i.e.*, $x_1+x_2=k$, so that $dy/dx_1=-dy/dx_2=\delta y/\delta x_1-\delta y/\delta x_2$. Probit mortality, Y, can be substituted for y in the equation. Thus, whether an active ingredient is better applied in concentrated or dilute form depends on the relative magnitudes of $\delta y/\delta x_1$ and $\delta y/\delta x_2$, or of $\delta Y/\delta x_1$ and $\delta Y/\delta x_2$. The equation is true whenever an insecticide consists of an active ingredient in a diluent, whatever the dosage-mortality relationship. Previous work is discussed in the light of the equation and its probit form, and it appears that the concentration at which an active ingredient is best applied can depend upon the nature and quantity of the active ingredient, and the method of application of the spray. There may be other factors.

The probit form of the equation is applied to the probit plane and confirmed experimentally. Flour beetles (*Tribolium castaneum*, Hbst.) were sprayed with pyrethrins in Shell oil P 31, and it was found that $\delta Y/\delta x_1>\delta Y/\delta x_2$, so that a given quantity of pyrethrins was more toxic in concentrated solution than in dilute.

Way (M. J.) & Synge (A. D.). **The Effects of D.D.T. and of Benzene Hexachloride on Bees.**—*Ann. appl. Biol.* **35** no. 1 pp. 94–109, 3 figs., 9 refs. London, 1948.

The following is based on the authors' summary. Laboratory and field tests were made in England in 1946 to determine the effects of DDT and BHC (benzene hexachloride) on honey bees and on wild bees of several species. The laboratory experiments* showed that BHC is a powerful contact and

*The senior author has asked us to state that the temperature at which the bees used in these tests were kept was 32°C.[89·6°F.] and not, as given in the paper, 32°F.—*Ed.*

stomach poison to honey bees, and the results of field experiments with commercial sprays used at concentrations of 0·013 and 0·052 per cent. γ isomer and a commercial dust at a concentration of 0·2 per cent. γ isomer confirmed its danger to the foraging bee population. Contact for only a few minutes with a treated surface was sufficient to cause death, and blossoms remained poisonous for at least three days after treatment. No repellent action was noted. Workers contaminated with BHC were able to return to the hive, and there is thus a further risk that nurse bees may be poisoned by contaminated pollen and nectar.

In the laboratory, DDT had a contact action at fairly high concentrations and was rather more toxic as a stomach poison than lead arsenate. In the field, commercial preparations on open blossoms were apparently harmless to foraging bees.

Workers of bumble bees (*Bombus* spp.) were about as resistant to contact with DDT and BHC as those of honey bees, but the queens and drones were more resistant, especially to DDT, which is of importance, since almost all the bees of this genus visiting the fruit blossom at the time when it is sprayed are queens, and their destruction would entail the loss of up to 500 workers per queen later in the season.

STOKER (R. I.). **The Phytotoxicity of D.D.T. and of Benzene Hexachloride.**—*Ann. appl. Biol.* **35** no. 1 pp. 110–122, 1 pl., 2 refs. London, 1948.

The following is based mainly on the author's summary of investigations in England in 1945–46. Spraying with a suspension in water of a proprietary dispersible powder containing 5 per cent. DDT and an emulsified solution of pure DDT in benzene, both at a concentration of 0·2 per cent. DDT, had a negligible effect on the maturation of outdoor tomatos and of summer cabbage, but the suspension damaged curcurbits and, in one of the two seasons, the base used in making it up distorted glasshouse cucumbers. Lettuce, radish, turnip, peas, beans, broad bean [*Vicia faba*] and carrot were not affected. Two commercial spray preparations of BHC (benzene hexachloride containing 10–12 per cent. γ isomer) applied at concentrations of about 0·01–0·0037 per cent. γ isomer did not affect the yield or flavour of tomatos, but concentrations higher than the normally recommended ones of 0·04–0·025 per cent. γ isomer severely scorched seedlings of radish, turnip, swede, kale, spinach and beetroot. Treatment with BHC dusts containing 0·1 and 0·05 per cent. γ isomer stunted radish seedlings. In one test, young potato foliage was damaged by emulsion and suspension sprays at relatively high concentrations (0·01 and 0·05 per cent. γ isomer, respectively) and by a dust containing 0·5 per cent. γ isomer, but late-season older foliage was unaffected. Sprays prepared from the dispersible powder caused tainting of potatoes, peas, carrot, beetroot, marrows, cauliflowers and lettuce, but not onions, and BHC dusts caused tainting of carrots. Apples and plums sprayed with BHC at concentrations of 0·01 and 0·05 per cent. γ isomer developed a taint after cooking [*cf. R.A.E.*, A **36** 13], but dessert apples were not affected.

The Fight against Colorado Beetle, 1946.—*Agriculture* **54** no. 3 pp. 121–124, 1 map, 1 ref. London, 1947.

An account is given of the occurrences of the Colorado beetle [*Leptinotarsa decemlineata*, Say] in England during 1946. Single imported beetles were found on 2nd April in London on lettuce from France, on 1st June at Wolverhampton on lettuce from Holland, and on 18th September on aubergines [*Solanum melongena*] landed at Croydon airport from France; in addition, the remains of a beetle were found on the dockside at Middlesborough, and a single adult

in a ship bringing sand and general cargo from Antwerp. During July and August, single adults were reported at four places near Croydon airport, six others in East Sussex, Kent, Essex and Cambridgeshire, and one on a vessel off Kent. All had apparently recently arrived in the country. Large numbers of larvae and several batches of eggs were discovered in mid-July in a potato crop near Sittingbourne, Kent, in a field in which potatoes had been grown during the previous year and in which there had probably been an undetected colony. Larvae, eggs or both were found during the next few weeks in fields and gardens at eight places in Sussex, Surrey, Essex, Middlesex, Cambridgeshire and Norfolk, and 25 adults, but no eggs or larvae, were collected during the harvesting of the potato crop from a field at Deal about the middle of August. Three beetles that had already entered the soil were found on 1st October in a field in another place in Kent from which the crop was being lifted.

In general, the control measures adopted resembled those employed in previous years [*cf. R.A.E.*, A **35** 311], but some small areas were dusted with DDT, and potato crops in three areas where infestation occurred in 1945 were sprayed extensively as a precautionary measure.

STAPLEY (J. H.). **Pests of Farm Crops.**—$8\frac{3}{4} \times 5\frac{1}{2}$ ins., [8+]325 pp., 19 pls., 23 figs., many refs. London, E. & F. N. Spon, Ltd., 1949. Price 21*s*.

This handbook deals with the invertebrate pests that attack grassland and field and vegetable crops in England, with special reference to the eastern counties, and is intended primarily for farmers. The relation between pests and crop plants and the circumstances that favour outbreaks are discussed in an introductory chapter, in which the different methods of control and some materials commonly used for this purpose are also reviewed. Specific pests are dealt with in six subsequent chapters devoted to insects, Arachnids, woodlice, Myriapods, slugs and eelworms. The chapter on insects takes up most of the book and comprises a short general account of their anatomy, development and classification, followed by information on the appearance, importance and bionomics of individual pests, the nature of the damage due to them, and the measures available for their control, which are discussed with regard to the practical considerations governing their use. The damage caused by individual pests and the season at which they are injurious are also shown in a table, in which they are classified according to the crop and the part of the plant they attack.

BERAN (F.). **Pflanzenschutz im Obstbau.** [Plant Protection in Orchards.]—*Scholle-Bücherei* **130** 184 pp., 35 pls., 5 refs. Vienna, Scholle-Verlag, 1947.

This book on the control of insect and other pests and diseases of tree and berry fruits in Austria opens with a general explanation of the various methods of control available and the preparation and uses of numerous insecticides and fungicides. The value of preventive treatments and timely application is stressed. This is followed by a section in which directions are given for control measures applicable to fruits in general and spray schedules for the individual sorts, with indications of the pests against which the treatments are directed, and a large number of charts, which form the main feature of the book, showing the seasonal development and appearance of the various stages of individual pests, the nature of the damage caused and the recommended control measures and their timing.

Quadraspidiotus (*Aspidiotus*) *perniciosus*, Comst., which is stated to constitute the greatest immediate danger to fruit cultivation in Europe, is dealt with in an appendix. The appearance of all its stages, the periods during which they

are present and their duration are shown in a table, the symptoms of infestation are described, and sprays for its control are recommended.

Beran (F.), Watzl (O.) & Fischer (R.). **Der Pflanzenarzt im Obst-, Schreber- und Hausgarten.** [The Plant Physician in Orchard, Allotment and Garden.]—*Tagbl. Bibl.* no. 1281, 2nd edn., 287 pp., 14 figs. Vienna, Globus-Verlag, 1948.

This is a popular handbook on pest control for gardeners and smallholders in Austria. It consists of a preliminary general section in which the process of metabolism in plants, the various biotic and abiotic factors that injure plants, different kinds of control measures and apparatus for the application of insecticides and fungicides are reviewed, and a section termed the practical part containing keys to the insect and other animal pests and diseases of fruits, vegetables and ornamental plants based on the injury caused, lists of the numerous injurious agents, including many insects, with notes on the appearance, habits and control of these, directions for the preparation and application of sprays, dusts, etc., a spray calendar for fruit trees and bushes and general hints on control.

Rademacher (B.). **Krankheiten und Schädlinge im Acker- und Feldgemüsebau. Ihre Erkennung und Bekämpfung.** [Diseases and Pests in Agriculture and Market-gardening. Their Identification and Control.]—*Schr. neuzeitl. Landb.* **12**, 182 pp., 93 figs., refs. Stuttgart, z.Z. Ludwigsburg, E. Ulmer, 1949. Price *DM.* 6.50.

This is one of a series of small agricultural handbooks and deals with modern methods of controlling pests and diseases of field and vegetable crops in Germany. The importance of plant protection and the various general factors against which it is required are reviewed in preliminary sections, notes are given on the appearance, habits, importance and control of the principal insect and other pests arranged under the crops they attack, considerable space being devoted to viruses and their vectors, and there is a general section on the various methods of control, including information on the preparation and uses of insecticides and a note on the official German Plant Protection Service and its functions.

Bennett (C. W.) & Costa (A. S.). **Tristeza Disease of** *Citrus*.—*J. agric. Res.* **78** no. 8 pp. 207–237, 3 figs., 35 refs. Washington, D.C., 1949.

The following is based on the authors' summary. Sweet orange on sour-orange rootstock in Argentina and Brazil has been severely affected by a virus disease known in Brazil as tristeza. It was first observed in these countries in 1930 or 1931 and about 1937, respectively, and appeared in Uruguay in 1940; the same or similar disorders, all capable of causing serious damage to this combination of scion and stock, have been reported from South Africa, Java, southern California and Victoria.

In experiments at Campinas, Brazil, transmission of tristeza was not obtained through the seed of sweet or sour orange or by inoculation of sap from diseased plants. When 91 sweet-orange plants were inoculated by dodder (*Cuscuta* spp.) trained to them from diseased plants, *C. subinclusa* caused one plant to become infected and *Cuscuta* sp. caused symptoms resembling tristeza in another, indicating that the disease may be transmissible to a low proportion of plants by this means. It was transmitted by budding or twig grafts to several varieties of sweet orange on sour-orange rootstock. In tests with *Aphis citricidus*, Kirk., which is abundant on *Citrus* in southern Brazil at certain

seasons, the virus was transmitted to small plants under greenhouse conditions by infesting them with Aphids from diseased plants ; a low proportion of plants infested with single examples became infected, but high proportions of infection were obtained with large batches of Aphids. In limited tests a period of starvation prior to feeding on diseased plants did not appear to increase the ability of the Aphids to transmit the virus. Transmission was obtained with Aphids only after they had fed for 60 minutes or longer on diseased plants. No transmission was obtained by means of *A. gossypii*, Glov., *Macrosiphum solanifolii*, Ashm., or *Aleurothrixus floccosus*, Mask., which were found feeding on *Citrus* trees in the field, or various species of Jassids or three other species of Aphids that were found on orange trees but are not known to breed on them.

A number of species of annual plants inoculated from infected sweet-orange trees through dodder or by infestation with *Aphis citricidus* developed no symptoms that indicated transmission of the virus. No symptoms known to be caused by it have been observed on any variety of *Citrus* or *Citrus* relative on its own roots, although some are known to be susceptible to inapparent infection and it is possible that certain types of vein yellowing observed occasionally on isolated twigs of trees of grapefruit and many other types of *Citrus* may be caused by the disease. In addition to sweet orange, which is also possibly injured on grapefruit rootstock, five other kinds of *Citrus* have been observed to be injured on sour-orange rootstock and in tests in which small plants were inoculated in the greenhouse by means of *A. citricidus*, sweet orange on grapefruit and shaddock rootstocks and some additional varieties of *Citrus* on sour-orange rootstocks developed typical symptoms. In tests in which small seedlings were inoculated by means of the Aphid, sweet-orange seedlings appeared to be more readily infected than sour-orange seedlings. The virus was transmitted by it to small sweet-orange plants on sour-orange rootstock from rough lemon, " cravo " tangerine, and an unidentified *Citrus* tree, all on their own roots and from the Pera variety of sweet orange on Rangpur lime, on none of which the disease was evident.

Methods of control that have been used in *Citrus* plantings in Brazil include inarching with resistant stocks, mounding the soil round the base of the trees to induce the production of a root system from the scion variety, top working with lemon and encouraging the growth of sour-orange shoots from the stock with the hope that they will supply the necessary food materials to the root system to prolong the productive life of the trees. For various reasons none of these has proved satisfactory for general use. Since a high proportion of the bearing trees of Brazil were on sour-orange rootstock and most of these have been killed or rendered valueless, control measures in the future will consist chiefly in making new plantings with trees of scion-stock combinations that are resistant to injury. Thus far, the most satisfactory rootstocks have proved to be sweet orange, rough lemon, Rangpur lime and sweet lime.

Papers noticed by Title only.

Liste officielle des noms français des insectes d'importance économique au Canada [including French, English and scientific names]. (**Préparee en collaboration et publiée en supplément du rapport annuel de la Société de Québec pour la Protection des Plantes.**)—66 pp. Quebec, Minist. Agric., 1947.

Gersdorff (W. A.). **Toxicity to House Flies of the Pyrethrins and Cinerins, and Derivatives, in Relation to chemical Structure.**—*J. econ. Ent.* **40** no. 6 pp. 878–882, 1 fig., 4 refs. Menasha, Wis., 1947. [See *R.A.E.*, B **37** 155 ; *cf.* also A **37** 106.]

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Revista Chilena de Historia Natural (Santiago) : Año ; 15 (1911) Nos. 3 to end; 16 (1912) ; 18 (1914) ; 26 (1922).

Revista Facultad Nacional de Agronomía, Colombia (Medellín) : No. 1 (1939).

Revista de Parasitología, Clínica y Laboratorio (later) Revista de Medicina Tropical y Parasitología, Bacteriología, Clínica y Laboratorio (Havana) : Vols. 1 (1935) No. 1 ; 2 (1936) Nos. 1–3 ; 3 (1937) ; 4 (1938 Nos). 1–2.

Revista de Veterinaria e Zootechnia (Rio de Janeiro) : Tomos 1–2 (1911–12) ; 3 (1913) Nos. 1–3, 5.

La Revue de Phytopathologie Appliquée (Paris) : Tome 1 (April–May, 1914) Nos. 22–23.

Revue des Sciences Médicales, Pharmaceutiques et Vétérinaires de l'Afrique Française Libre (Brazzaville) : Tome 1 (1942) Nos. 1, 3, 4.

Rhodesia Agricultural Journal (Salisbury) : Vol. 1 Nos. 1, 3–6 ; 2 Nos. 2, 4 ; 3 Nos. 1, 2, 6 ; 4 No. 4 ; 5 No. 4 (1903–08) ; 7 (1909–10) Nos. 1 & 6 ; 10 (1912) No. 1 ; 43 (1946) No. 4 ; 45 (1948) No. 6 ; title-pages & indices to vols. 1, 2, 4, 5, 8, 9.

Sciencia Medica (Rio de Janeiro) : Anno 1 (1925) Nos. 2–3, 5–6 ; 2 (1926) Nos. 1–10, 12.

Soap & Sanitary Chemicals (New York, N.Y.) : Vol. 20 (1944) No. 9 ; Blue book 1945.

South London Entomological and Natural History Society : Reports 1879–84.

Tennessee Agricultural Experiment Station (Knoxville, Tenn.) : 10th (1897), 12th (1899) and 16th (1903) Annual Reports.

Tennessee State Board of Entomology (Knoxville, Tenn.) : Bulletins 15, 24, 25, 28, 29, 34, 39.

Teysmannia (Batavia) : 32ste Jaarg. (1921) 10e Afl.

Tijdschrift over Plantenziekten (Wageningen) : Jaarg. 1 (1895) ; 16–17 (1910–11).

Timehri : The Journal of the Royal Agricultural and Commercial Society of British Guiana (Demerara) : Third Series, Vols. 1 (1911) Nos. 1–2 ; 2 Nos. 2 to end ; 3 Nos. 2 to end ; 4–5 (1913–18).

Travancore Department of Agriculture (Trivandrum) : Report for 1931–32.

Tropicheskaya Meditzina i Veterinariya (Moscow) : God 8 (1930) Nos. 2–5.

Trudui Po Zashchite Rasteniĭ (Leningrad) : Series 3 vuip. 5 (1935).

United States Department of Agriculture (Washington, D.C.) : Howard (L. O.). Report of the Entomologist, 1895.

Virginia. State Inspector for San José Scale : 1st Annual Report 1896–97 (Richmond, Va., 1897) ; State Entomologist and Plant Pathologist : 4th Report (Richmond, Va., 1905).

West Indian Bulletin (Barbados) : title-page & index to vol. 4.

Zeitschrift für das Landwirtschaftliche Versuchswesen in Österreich (Vienna) : 21 Jahrg. (1918) Hefte 1–3, 10–12.

Zeitschrift des Wiener Entomologen-Vereins (der Entomologischen Gesellschaft) (Vienna) : Jahrg. 24 (1939) Hefte 9–29 (1944).

Agricultural Chemicals (New York, N.Y.) : Vol. 1 (1946) Nos. 1–5.

Agricultural Journal, Department of Agriculture, British Columbia (Victoria : Vol. 1 (1916) Nos. 1–2.

Agricultural News (Barbados) : Nos. 1, 25, 26, 34, 66 (1902–04).

Agriculture and Animal Husbandry in India (Delhi) : 1937–38 & 1938–39.

American Journal of Veterinary Research (Chicago, Ill.) : Vols. 1 & 2 (1940–41) Nos. 1–5.

Analele Institutului de Cercetări Agronomice al României (Bucharest) : Tome 14 (1942).

Annals of the Queensland Museum (Brisbane) : No. 5.

Arbeiten der Biologischen Station zu Kossino (Moscow) : Lief. 1 (?1925).

Archives de l'Institut Pasteur de Tunis : 1906 fasc. 4 ; 1907 fasc. 1 & 3 ; 1908 ; 1909 fasc. 1–2, 4 ; 1910 fasc. 1–3 ; 1911 fasc. 3–4.

Archives du Musée Zoologique de l'Université de Moscou : Vol. 5 (?1938).

Arizona Commission of Agriculture and Horticulture (Phoenix, Ariz.) : 1st–10th Annual Reports ; Circulars 15–16 (1909–18).

Arquivos do Instituto Bacteriológico Câmara Pestana (Lisbon) : Vol. 1 (1906).

The Bee World (Benson, Oxon.) : Vols. 1–2 (1919–21).

Bericht über die Wissenschaftlichen Leistungen im Gebiete der Entomologie während des Jahres 1914 (Berlin) : Nos. 1 & 5.

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